BRITISH STANDARD 308 : 1943

ENGINEERING DRAWING OFFICE PRACTICE

BRITISH STANDARDS INSTITUTION

RECOMMENDATIONS FOR BRITISH STANDARD

Engineering DRAWING OFFICE PRACTICE

B.S. 308 : 1943

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BRITISH STANDARDS INSTITUTION
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Telegrams : Standards, Sowest, London. Telephone : Abbey 3333

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CO-OPERATING ORGANISATIONS

The Mechanical Industry Committee under whose supervision this British Standard was prepared consists of representatives from the following Government Departments and Scientific and Industrial Organisations :

*Admiralty
Crown Agents for the Colonies
Department of Scientific and Industrial Research
High Commissioner for India
Home Office
Ministry of Health
*Ministry of Supply
Ministry of Transport
Ministry of Works
*War Office
Agricultural and Road Machinery Manufacturers' Association
Association of Consulting Engineers
British Chemical Plant Manufacturers' Association
British Compressed Air Society
*British Electrical and Allied Manufacturers' Association
British Engineers' Association
British Iron and Steel Federation
British Marine Oil Engine Manufacturers' Association
Engineering Insurance Companies
Institute of Marine Engineers
Institute of Petroleum
Institution of Automobile Engineers
*Institution of Civil Engineers
Institution of Gas Engineers
Institution of Heating and Ventilating Engineers
*Institution of Mechanical Engineers
*Institution of Production Engineers
Locomotive Manufacturers' Association
Machine Tool Trades Association
Railway Companies of Great Britain

The Government Departments and Scientific and Industrial Organisations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of this British Standard.

Ministry of Aircraft Production
Board of Education
H.M. Stationery Office
Imperial College of Science and Technology
Drawing Office Material Manufacturers and Dealers' Association
Society of Motor Manufacturers and Traders
Society of British Aircraft Constructors
Association of Engineering and Shipbuilding Draughtsmen

THIS BRITISH STANDARD having been approved by the Mechanical Industry Committee and endorsed by the Engineering Divisional Council was published under the authority of the General Council on 13th December, 1943.

These recommendations are based on the use of British units, but are generally applicable also to the metric system.

They are intended to apply to new drawings made in connection with a contract when placed, and should not preclude the submission, by the manufacturer or contractor, of drawings previously prepared in accordance with the conventions which he has been accustomed to employ hitherto.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the Committees charged with the revision of the standards to which they refer.

A complete list of British Standards indexed and cross-indexed for reference will be found in the Institution's Yearbook.

British Standards to which references are made in these recommendations are listed on pages 31 & 32 and 43 to 46. Reference is also made to B.S. 164, Limits and Fits for Engineering, and to B.S. 1134, Surface Finish.

British Standards are revised, when necessary, either by the issue of amendment slips or by the issue of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or edition. If users wish to be kept informed of any alteration to this standard notification should be made to Publications Department of the Institution, giving the number and title of the Standard.

RECOMMENDATIONS FOR BRITISH STANDARD

ENGINEERING
DRAWING OFFICE PRACTICE

FOREWORD

This Specification which has been prepared under the authority of the Mechanical Industry Committee, supersedes B.S. 308 : 1927, Engineering Drawing Office Practice. The Technical Committee constituted to draft proposals for this revised and amplified edition had before them the two-fold purpose of establishing a Standard and providing a useful guide which will enable young engineers and draughtsmen to proceed with much of their work without too frequent reference to their seniors, following the lead of the American and Australian Standards in these respects.

The urgent need of providing the trimming allowance necessary for economical printing has been solved by retaining the former standard sizes of drawings and tracings and specifying, for each of these sizes, maximum frame or border line sizes. Three additional sizes and one minor alteration of size have been included, two of these conforming to drawing sheets in common use and the other two to commercial stationery.

Having thus increased the list of standard sizes to include all those in most common use, it is confidently hoped that orders for sizes outside this extended range will be reduced to a minimum.

It has been considered preferable to include references to other British Standards which are helpful to the designer and draughtsman rather than reprint extracts from them. By adopting this course the subsequent revision of subject matter to which reference is made will not necessarily entail revision of this British Standard on engineering drawing office practice.

The Committee have confirmed the recommendation, contained in B.S. 308 : 1927, that conventions of cross hatching to represent materials should be limited to those habitually used for wood and concrete. They have included a few of the firmly established existing conventions with regard to colours when these are required to be used.

The difficult subjects of tolerancing, the application of limits and fits, and grades of surface finish have merited the attention of special Technical Committees and separate publications will be issued in due course relating to these matters.

The Committee wish to express their indebtedness to the helpful comments received from many firms and associations and to the American and Australian Standards for engineering drawing practice.

TYPICAL DRAWING

A typical manufacturing drawing for a machined part embodying many of the drawing office practices recommended in this British Standard is illustrated in Plate 4.

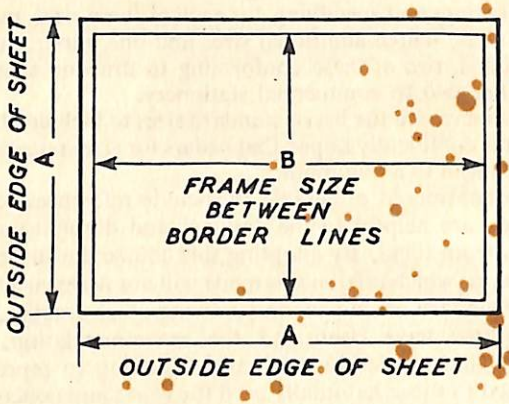
SIZES OF DRAWINGS AND TRACINGS

1. The list of recommended standard sizes is based on the following considerations :

a. The economical use of standard rolls of drawing and tracing paper, tracing cloth and sensitised paper and cloth, all of which are manufactured in 30 in. and 40 in. widths. When cut or printed sheets are used, these in the first place, have to be cut from 30 in. and 40 in. rolls.

b. The provision of a blank border which will enable prints to be trimmed if necessary without incurring the use of uneconomical sizes of sensitised material to allow for trimming. Finished prints which have been trimmed will then be slightly less in size than the original drawings but not less than the frame or border line size of the drawings.

c. The inclusion of such sizes as 40 in. × 27 in., 30 in. × 22 in. and 27 in. × 20 in. which are in common use, and for which drawing boards, plan cabinets and filing receptacles exist. Also the inclusion of the sizes 13 in. × 8 in. and 10 in. × 8 in. in order to conform with commercial stationery.



Sizes of drawings and tracings. Overall dimensions in inches across edges of sheet. A	Maximum frame size. Dimensions in inches between border lines. B
72 × 40	70 × 38
60 × 40	58 × 38
53 × 30	52 × 29
40 × 30	39 × 29
40 × 27	39 × 26
40 × 15	39 × 14
30 × 22	29 × 21
30 × 20	29 × 19
27 × 20	26 × 19
20 × 15	19 × 14
15 × 10	14¼ × 9¼

Additional sizes to conform with commercial stationery :

Sizes of drawings and tracings. Overall dimensions in inches across edges of sheet.	Maximum frame size. Dimensions in inches between border lines.
A	B
13 × 8	12¼ × 7¼ } See note
10 × 8	9¼ × 7¼ } below.

NOTES. 1. B sizes are the recommended *maximum* border line sizes; these border lines may be drawn further in from the edge of the sheet if desired.

2. Drawing, tracing and sensitised sheets should be cut to sizes A. After printing, the sensitised sheets may be trimmed if necessary but it is recommended that the prints be left as large as possible. The border lines which appear on the drawings and tracings should not be trimmed off the prints.

3. No notes or figures which are required to be reproduced on the print should appear outside the border lines.

4. On the commercial stationery size sheets border lines may be omitted if desired, but it is recommended that the drawing space utilised should not exceed that determined by the B dimensions.

5. It is recommended that all drawings and tracings should be marked with the standard sheet size (A size) in inches in a convenient place immediately inside the border lines.

SIZES OF DRAWING BOARDS

2. The sizes of drawing boards in common use are :

Antiquarian	54 in. × 32 in.
Double Elephant	42 in. × 29 in. See note.
Imperial	31 in. × 23 in.
Half Imperial	23 in. × 16 in.

NOTE. Manufacturers can provide drawing boards 42 in. × 32 in. to take 40 in. × 30 in. drawings and it is recommended that this size should be used in future in place of the Double Elephant size, 42 in. × 29 in.

LAYOUT OF DRAWING SHEETS

3. *a. Title Blocks.* In many drawing offices it is considered preferable for Standard Size sheets to be bought already cut to size and printed. This is productive of neatness and uniformity, facilitates the reading of drawings, and makes it possible for items, such as Drawing No., Name of Firm, Description or Title of Drawing, etc., to be easily found, especially when using drawings prepared by outside sources.

The *title block* is therefore an important printed feature and should be placed at the *bottom right hand corner* of the sheet. It is recommended that spaces should be provided for the following information on all title blocks.

Drawing No.
Name of Firm.
Description or Title of Drawing.
Date and Signatures.
Scale.

b. Repetition of Drawing No. or Part No. This should be placed in the *top left hand corner*, so as to be readily visible when vertical filing is adopted.

c. Additional Information. Where appropriate, additional information and notes may be included as follows :

(i) Material List. This should be placed immediately *above* the title block and may include such items as, Part No., description of part, material, quantity required.

The raw material from which parts are to be made should be clearly specified to be in accordance with a British Standard or other accepted specification ; where necessary the grade of that particular material should also be indicated.

(ii) Job or Order No.

(iii) Treatment, finish, etc.

(iv) Key to machining and other symbols.

(v) Tolerance of dimensions without specified limits.

(vi) Tool and Gauge references.

(vii) General Notes. These should be placed immediately *below* the top border line near the centre of the sheet.

(viii) Other information. In addition to the foregoing, individual Drawing Offices will naturally add to their standard sheets other information suited to their manufacturing procedure.

d. Typical Title Blocks. Typical title blocks incorporating these recommendations, where necessary, are illustrated in Plates 1, 2 and 3.

Plate 1. *For detail parts.* In general only one part is shown on a given sheet, the size of which will vary to suit the actual detail. For quantity manufacture, it is preferable not to have to refer to any other data sheet, and consequently the drawing should be as complete as possible. This can be achieved by including in the Title Block : Drawing or Part No. ; Part Name ; Scale ; Material Specification ; Material Form and Treatment ; Finish ; Machining Symbols ; Standard Tolerance for *unlimited* machine dimensions ; Signature and Date Columns ; Name of Firm. This information can be accommodated on the smallest sheet, namely 10 in. × 8 in.

NOTE. When a separate drawing is made for each detail part, some organisations identify the drawing by a part number reference ; others find it convenient to use the drawing number as the identification number of the article.

Plate 2. *For structural and general engineering and assembly drawings.* In this case more than one part will generally be shown and the Title Block may include : Drawing No ; Description or Title ; Scale ; Finish ; Signature and Date Columns ; Name of Firm.

Plate 3. *For jig and tool, machine and gauge drawings.* Here, quantities are not usually involved, and it is useful for Jig and Tool drawings to include details and assembly on one sheet. The Title Block may include : Drawing No. ; Job No. ; Description ; Scale ; Standard Fits ; Machining Symbols ; Signature and Date Columns ; Name of Firm.

e. Revisions. It is most important that drawings should record all alterations which are made. A convenient form is a table giving Revision No. (or Letter), Date, Signature and brief record of change.

Where interchangeability of a part is not affected, either in the dimensional sense or for other reasons, the drawing number or part number should not be changed. If interchangeability is affected, a new drawing number or a new part number should be given to the detail or details concerned.

In order that the position of a revision can be found readily on the drawing it is recommended that the revision No. or letter be repeated in proximity to the modified dimension or other detail, and the number or letter enclosed by an easily recognisable geometrical figure such as a circle or square.

In conjunction with revisions to drawings it is usual to issue a form or note to record the change, to ensure the replacement of existing prints made obsolete by the change, and to give the disposition of any existing parts or work in progress, and other details which may be needed by the manufacturing departments.

PLANNING THE DRAWINGS

4. *a.* Where a number of drawings are required to detail a complete design, a key drawing or a layout or assembly drawing is necessary. Such drawings will show the project to a convenient scale, and the drawing numbers, which deal with each part or section in detail, may be recorded in suitable tabular form on the drawing or on a separate sheet usually known as a ' drawing list.'

b. An alternative method, particularly applicable to structural work, is to include on each individual sheet of a series of drawings a small key plan, elevation or both, conveniently placed preferably near to the Title Block, indicating in bold lines to which part of the whole work the particular sheet refers. An example is given in Fig. 1.

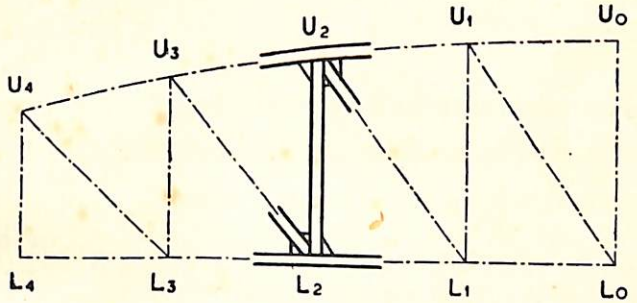


Fig. 1. Key diagram

c. When several parts are shown on one drawing they should preferably be grouped according to the process involved ; i.e., parts machined from bar material, castings, welded structures, sheet metal work, etc., should be grouped respectively on the same sheet.

d. Wherever appropriate, the main view of a detail should have the same orientation as that of the same part as given on the assembly drawing.

e. As a rule, ship and marine engineering drawings are made forward to the right, aft to the left.

NUMBERING AND REFERENCING

5. *a. Numbering.* The system of numbering drawings will be a matter for individual firms or departments but, in general, the following rules should be observed.

(i) A Register, Book or Master File should be used for the systematic allocation of Drawing Nos.

(ii) When a given part is changed so as to be no longer interchangeable with the previous design, either in the dimensional sense or for any other reason, a new Drawing or Part No. should be given, as indicated in Clause 3 *e*.

(iii) Any given part, although it may be used in various models, types or sizes of mechanism, should always retain the original Drawing or Part No. and should be detailed on one drawing only.

(iv) Wherever possible, right and left hand parts or assemblies should have consecutive Drawing or Part Nos.

b. Referencing. Where assembly drawings comprise a large number of parts it is recommended that part reference numbers should be arranged as far as possible in vertical columns or horizontal rows in the most convenient groupings outside the drawn views, with pointer lines indicating the respective parts by means of arrow heads or dots.

These part reference numbers should be ringed with a circle, or other geometrical figure to facilitate the location of the numbers when reading the drawing.

SCALES

6. The following scales are recommended :

General Engineering.

Full size (1/1)	¾ in. = 1 ft. (1/16)
Half size (1/2) (see note below)	½ in. = 1 ft. (1/24)
	⅜ in. = 1 ft. (1/32)
3 in. = 1 ft. (1/4)	¼ in. = 1 ft. (1/48)
1½ in. = 1 ft. (1/8)	⅛ in. = 1 ft. (1/96)
1 in. = 1 ft. (1/12)	1/16 in. = 1 ft. (1/192)

Where scales greater than full size are required scale multipliers of 2, 4, 8 and 10 are recommended.

For indicating the scale in the appropriate division of the Title Block a simple abbreviation is :

Scale 1/1 (for full size).
Scale 1/4 (for quarter size).
Scale 2/1 (for twice full size) and so on.

NOTE. Original details should be drawn to scale. Full size is recommended wherever possible, rather than half size.

Surveys.

6 in. to the mile.

$\frac{1}{2500}$

88 ft. to the inch.

$\frac{1}{500}$

40 ft. to the inch.

Earthworks.

20 ft. to the inch. Longitudinal sections are often drawn to distorted scales, such as $\frac{1}{2500}$ horizontally and 20 ft. to the inch or 40 ft. to the inch vertically.

Metric Scales.

Where metric scales are used these should normally be selected from 1/1, 1/2, 1/5 and 1/10 and decimal multiples or sub-multiples of these fractions.

TYPES OF LINES

7. For general engineering drawings the types of lines shown in Fig. 2 should be used.

a. ——————————————————————

Continuous (thick)

Use for : Visible outlines ; border lines of sheets.

b. ——————————————————————

Continuous (thin)

Use for : Dimension lines : projection or extension lines for dimensions ; hatching or sectioning ; pointer lines for notes and for adjacent parts.

c. —

Short dashes (thin)

Use for : Hidden details ; existing installations or portions to be removed.

d. ——— - ——— - ——— - ——— - ———

Long chain (thin)

Use for : Centre lines ; path lines (indicating movement) ; cutting planes or section lines (i.e., traces of cutting planes).

e. — - — - — - — - — - — - — - — - — - — - — - —

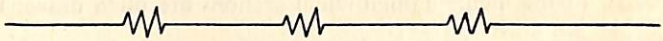
Short chain (thin)

Use for : Developed or false views ; adjacent parts.

f.

Continuous wavy (thick)

Use for : Irregular boundary lines ; short break lines.

g. 

Ruled line and short zig zags

Use for : Long break lines.

Fig. 2. Types of lines

The outline, type *a* line, should be outstanding in appearance on the drawing and those lines specified as thick in Fig. 2 should be from two to three times thicker than those specified as thin. The actual thickness of the line should be governed by the size and character of the drawing. Lines should be dense to produce good prints.

Centre lines should project for a short distance beyond the outline to which they refer, but where necessary to aid dimensioning or to co-relate views, they should be extended accordingly.

Short break lines, type *f* should be used to shorten the view of long uniform parts. See Fig. 3.

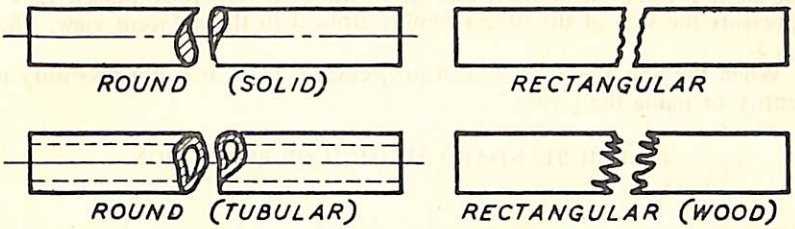


Fig. 3. Conventional breaks

An alternative position, or the limiting position, of a moving part, should be identified by type *e* line. The path line of a moving part should be identified by type *d* line. See Fig. 4.

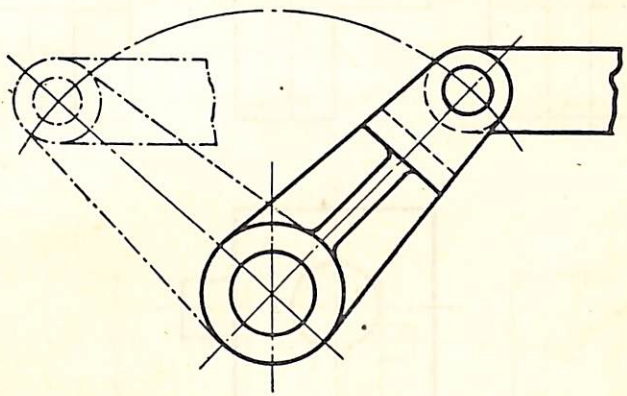


Fig. 4. Indication of alternative position

The lines recommended for boundaries on Engineering Survey Plans are shown in Appendix V : ' Engineering Survey Plans : Lines and Topographical Symbols.'

METHODS OF PROJECTION AND ARRANGEMENT OF VIEWS

8. *a.* First angle projection. The British Standard method of projection is first angle projection, namely, that in which each view is so placed that it represents the side of the object remote from it in the adjacent view. See Fig. 5.

When the first angle method of projection is used, it is not necessary to identify or name the views.

BRITISH STANDARD METHOD OF PROJECTION

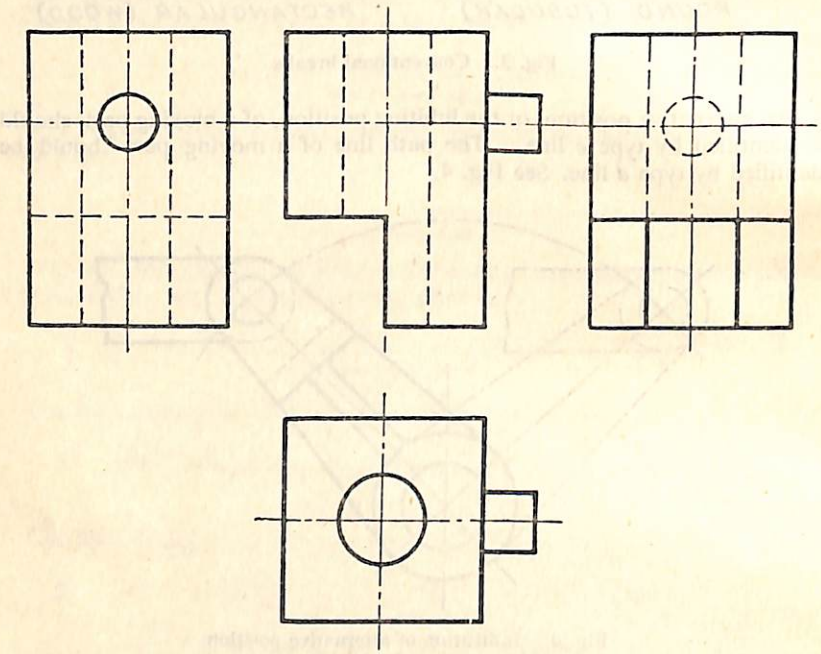


Fig. 5. First angle projection

If, for special reasons, it is desired to use any method other than first angle, the drawing should clearly indicate the method by a note, by arrows showing the direction of aspect of the various views in relation to each other, or by some other suitable means.

b. Third angle projection. In the third angle method of projection each view is so placed that it presents the side of the object near to it in the adjacent view, thereby bringing the features of adjacent views in juxtaposition. See Fig. 6. When the third angle projection is employed, it is recommended that a prominent note should be printed on the drawing ' Third Angle Projection.'

PLAN VIEW BB

PD 827

Amendment No. 1 : September, 1948

to B.S. 308 : 1943

Engineering Drawing Office Practice

Clauses 8a and b and figs. 5 and 6 to be amended as follows :—

METHODS OF PROJECTION AND ARRANGEMENT OF VIEWS

8a. **First-angle projection** is that in which each view is so placed that it represents the side of the object remote from it in the adjacent view. See Fig. 5.

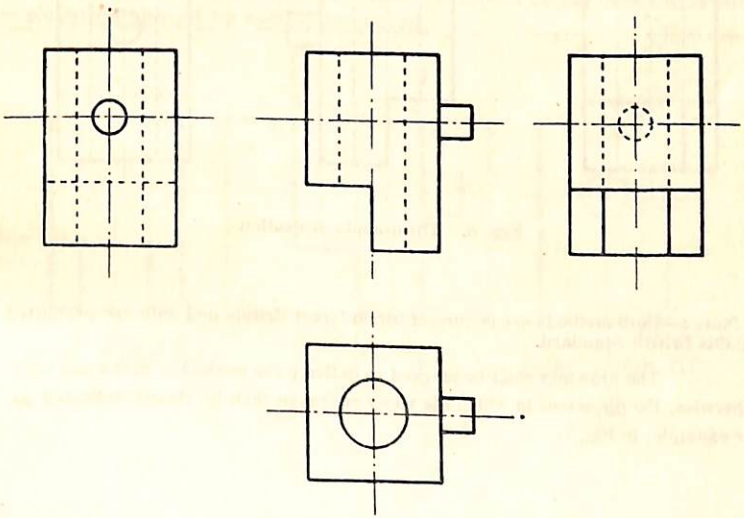


Fig. 5. First-angle projection

b. **Third-angle projection** is that in which each view is so placed that it represents the side of the object near to it in the adjacent view, thereby bringing outstanding features of adjacent views in juxtaposition. See Fig. 6.

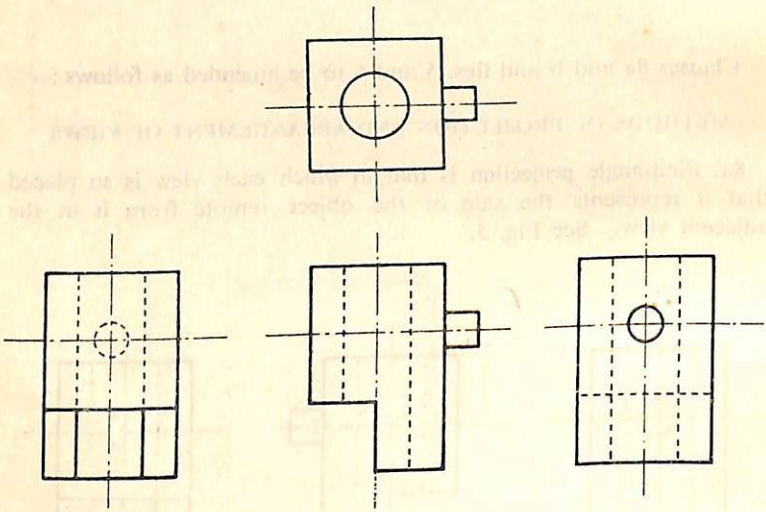


Fig. 6. Third-angle projection

Note :—Both methods are in current use in Great Britain and both are permitted by this British Standard.

The drawings shall be marked to indicate the method of projection used, otherwise, the directions in which the views are taken shall be clearly indicated as, for example, in Fig. 7.

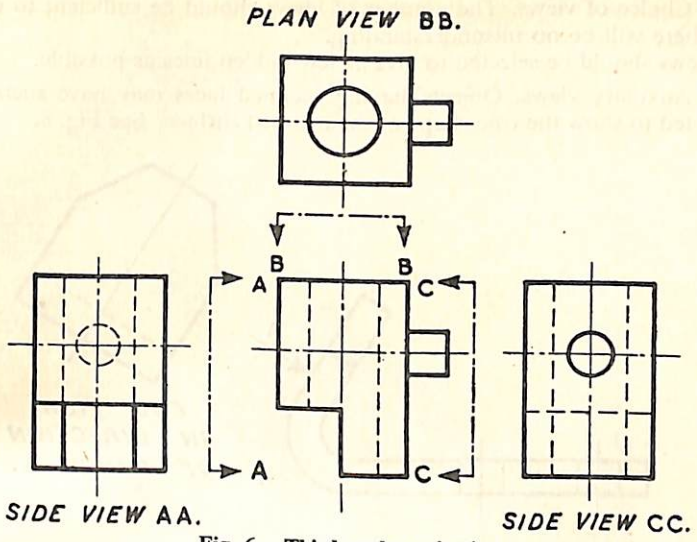


Fig. 6. Third angle projection

c. Combination of first and third angle projections. An example of a combination of first and third angle projections is shown in Fig. 7, where, in relation to the elevation, side views are so placed that they are in third angle projection and plan view in first angle projection. When using a combination of projections, it is important that the aspect of the views in relation to the elevation should be clearly indicated.

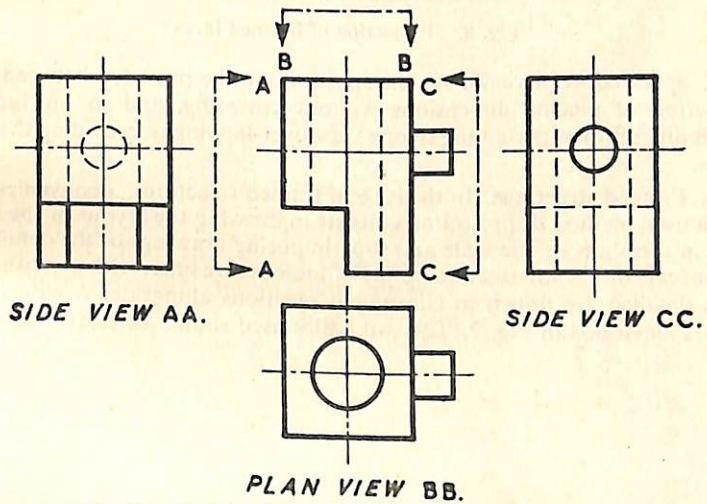


Fig. 7. Combination of first and third angle projection

d. Choice of views. The number of views should be sufficient to ensure that there will be no misunderstanding.

Views should be selected to give as few hidden lines as possible.

e. Auxiliary views. Objects having inclined faces may have such faces projected to show the true shape of the inclined surface. See Fig. 8.

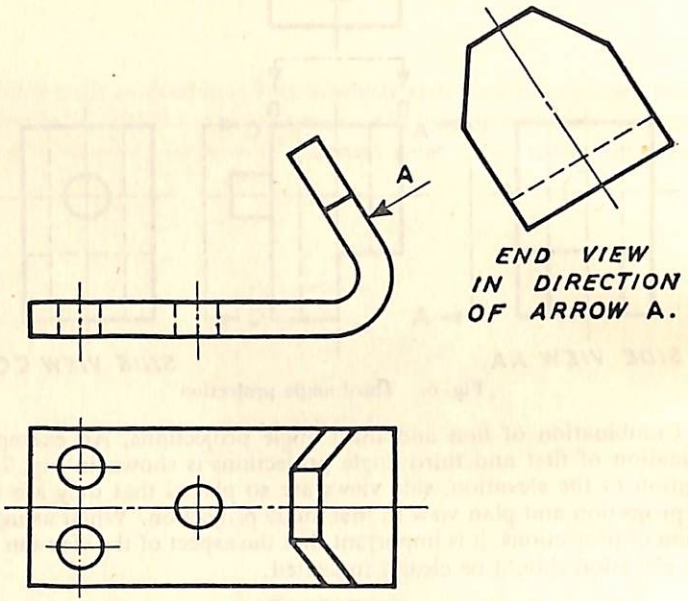


Fig. 8. Projection of inclined faces

f. Space between views. Ample space should be provided between views to permit of placing dimensions without crowding, and to preclude the possibility of notes pertaining to one view over-lapping or crowding the other views.

g. Framed structures. In the case of framed structures, a convenient and much used method of projection consists in drawing the layout of the centre lines of members to one scale and superimposing drawings of the details to a larger scale on the intersection points of these centre lines. Other views of the parts detailed are drawn in convenient positions alongside. A case of this kind is illustrated in Fig. 9. The two scales used should be clearly indicated.

Scales
(As drawn before reduction)
Centre lines : $\frac{1}{4}$ in. = 1 ft.
Details : $\frac{1}{2}$ in. = 1 ft.

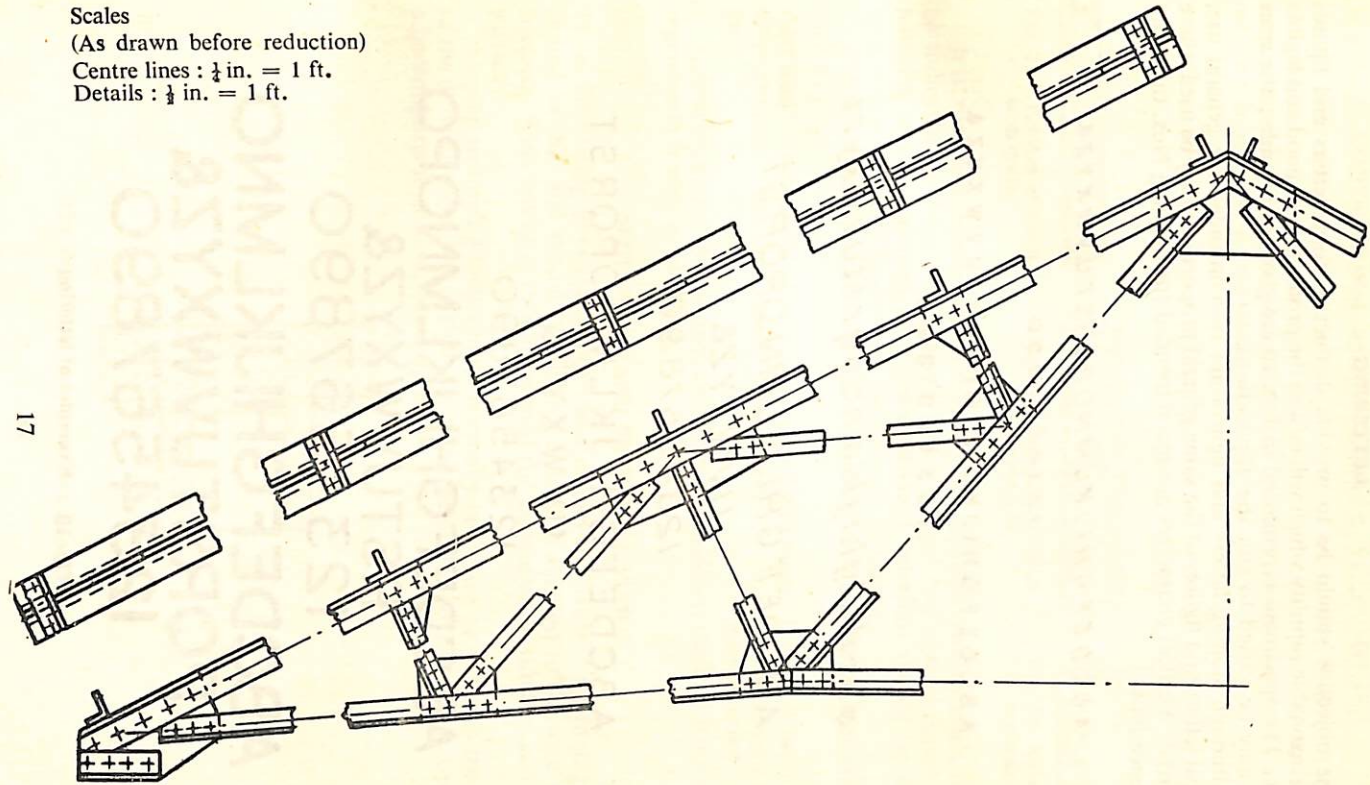


Fig. 9. Framed structure

LETTERING

9. The objective should be to provide distinct uniform letters and figures with reasonable rapidity which will ensure the production of good and legible prints. The specimens reproduced in Fig. 10 are given as a guide ; the sizes used may be varied to suit the applications.

Although sloping letters and figures are recommended for general use, vertical letters and figures of the same general proportions may be used where preferred. Vertical characters are recommended for drawing Nos. titles and reference Nos.

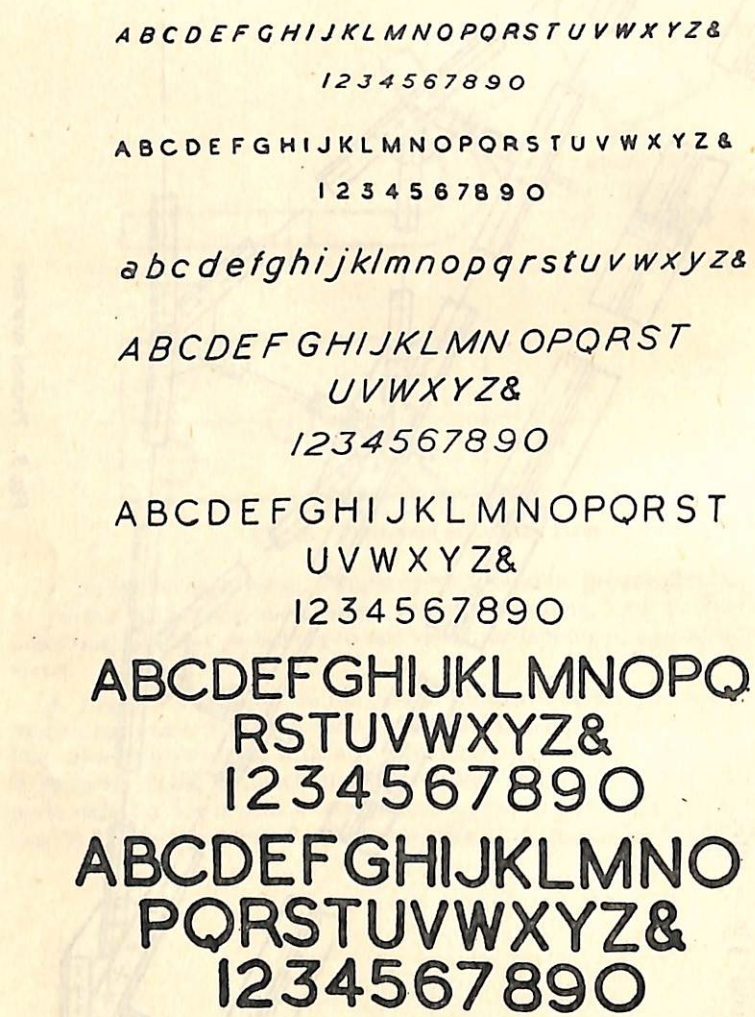

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0
a b c d e f g h i j k l m n o p q r s t u v w x y z &
A B C D E F G H I J K L M N O P Q R S T
U V W X Y Z &
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I J K L M N O P Q R S T
U V W X Y Z &
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I J K L M N O P Q
R S T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0

Fig. 10. Examples of lettering

CONVENTIONAL REPRESENTATION OF MATERIALS

10. In view of the large variety of materials used, it is undesirable to rely on the various conventions of cross hatching except in the cases of wood and concrete, which it is recommended should be as shown in Figs. 11, 12 and 13, where a convention is required.

Fig. 11. Section of wood with grain

Fig. 12. Section of wood across grain

Fig. 13. Section of concrete

It is, therefore, recommended that in every case different materials should be indicated by notes on drawings and tracings. Any special means (e.g., hatching or colours) used to indicate different materials should be shown by a note or in a key diagram on the drawing or tracing.

Colours, when used, should be in accordance with existing conventions, such as :

Cast iron	*Payne's Grey.*	Brass and gun metal	*Light Yellow.*
Wrought iron	*Prussian Blue.*	Brickwork	*Light Crimson Lake.*
Steel	*Purple.*	Timber	*Burnt Sienna.*

Colouring and coloured lines should not be used on tracings from which reproductions may be required.

SECTIONING AND SECTIONAL VIEWS

11. *a.* Sectioning lines (hatching). As specified in Clause 7 sectioning lines should be thin and should be suitably spaced in relation to the area to be covered. Wide hatching should be used for large area sectioning and large surfaces.

Sloping sectioning lines should normally be drawn at 45° with the edge of the drawing sheet, and at right angles to each other to distinguish between adjacent parts in section. See Fig. 14.

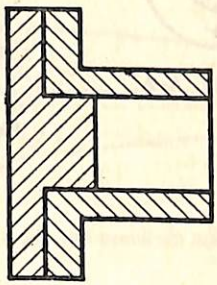


Fig. 14. Sectioning lines for adjacent parts

Where the outlines of a section are at a pronounced angle with the edges of the drawing sheet, the sloping sectioning lines should be drawn at a suitable angle to the outline.

In sectional views, the sectioning lines for a given part should be in one direction even where the section does not lie wholly in one plane.

Where large areas of sectioning have to be shown, especially those done free-hand, such as concrete, it is recommended that the edges only be sectioned as indicated in the example for that material in Fig. 13.

Sectioning lines should be interrupted for dimensions or lettering. See Fig. 15.

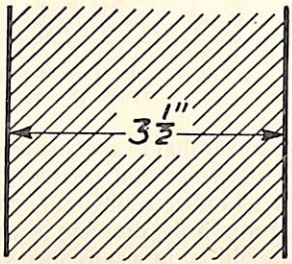


Fig. 15. Hatching interrupted for dimensions

b. Location of sectioning planes. The position of a sectioning plane should be indicated on one or more views of an object by letters and arrows of bold type, pointing in the direction in which the object is viewed in section. See Figs. 16, 17 and 18.

The following examples illustrate the methods which should be adopted.

(i) A section in one plane, not on a centre line. See Fig. 16.

(ii) A section in one plane along a centre line. See Fig. 17.

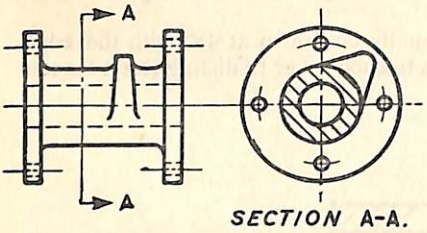


Fig. 16. Section in one plane not on centre line

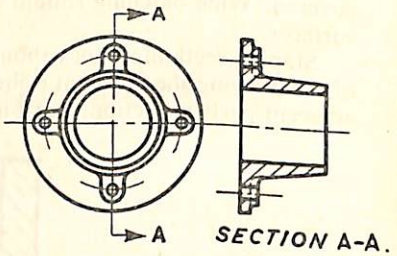


Fig. 17. Section in one plane along centre line

(iii) The path of a section in two or more planes or in a curve should be indicated completely, as in Fig. 18. The type of line indicating the path should be as type *d*. Clause 7 ; where necessary for clarity the line can be made thicker.

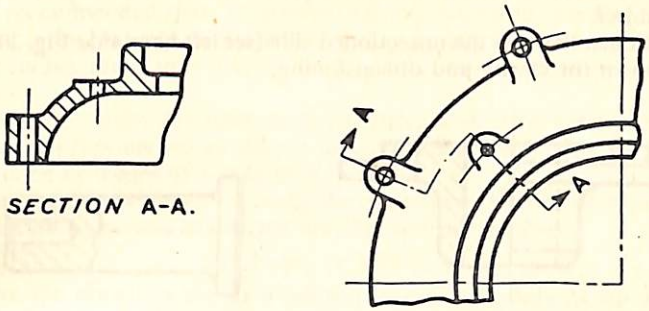


Fig. 18. Section in two planes

c. An exception to the general rule for indicating sections should be made where the sectioning plane passes through ribs, shafts, bolts, nuts, rods, rivets, keys, pins, and similar parts. These should be shown by outside views and not in section. See Fig. 19.

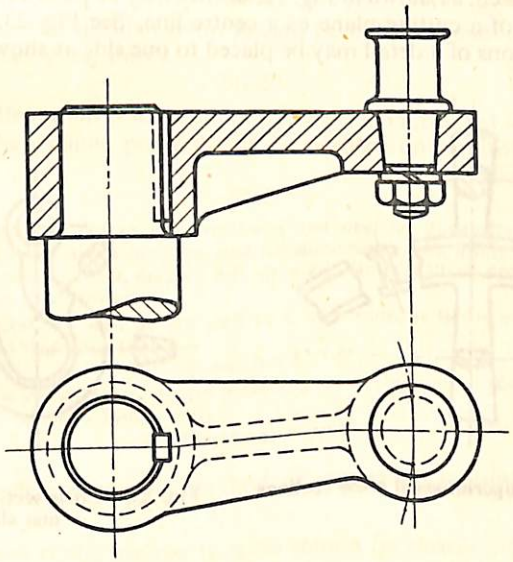


Fig. 19. Rib, shaft and crankpin not shown in section

d. Convenient methods of showing sectional views :

(i) Objects which are symmetrical about a centre line may be drawn having one half in outside view and the other half in section. Fig. 20.

Hidden lines behind the cutting plane (see right hand half section Fig. 20) should be omitted unless required for the necessary description of the object.

Hidden lines on the unsectioned side (see left hand side Fig. 20) should be shown for clarity and dimensioning.

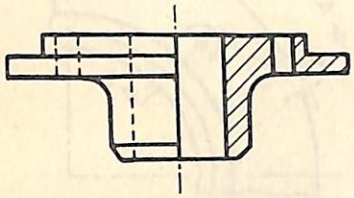


Fig. 20. Half section

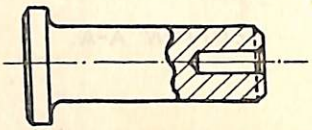


Fig. 21. Part section

(ii) Part sections may be taken at convenient places to show detail which would otherwise be hidden, the boundary of such sections being shown by an irregular boundary line, type *f* line. See Fig. 21.

(iii) Cross sections of details such as the arm of a wheel may be superimposed, as shown in Fig. 22, or they may be placed to one side on an extension of a cutting plane as a centre line. See Fig. 23. Alternatively, cross sections of a detail may be placed to one side as shown in Fig. 18.

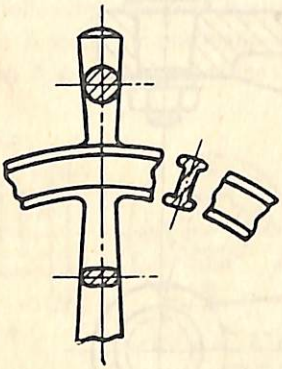


Fig. 22. Superimposed cross sections

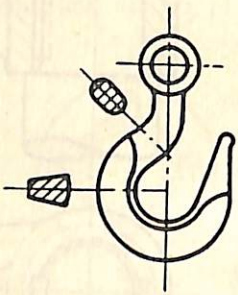


Fig. 23. Cross section placed to one side

DIMENSIONING

12. *a.* Units. The standard method of dimensioning is in inches, or in feet and inches, expressed thus :

$7\frac{5}{8}''$; 7·625″ ; 6′–2″.

It is recommended that, in general, dimensions up to two feet should be expressed in inches only, and above two feet, in feet and inches, but dimensions in inches only, to a greater length than two feet may be adopted if desired.

When other units are used, such as chains and links, the abbreviations ch., lk., or appropriate letters should be placed after the figures, or their use clearly stated by means of a general note.

When the metric system is used, the dimensions should be expressed in millimetres or in metres, as the case may be, and written thus :

25·4 mm. or 3·05 m.

Where the drawings are dimensioned in one unit only as for instance, wholly in inches or wholly in millimetres, the symbols ″ and mm. may be omitted, always provided that a prominent note be added stating the unit in which all dimensions on the drawing are expressed.

b. Fractions. Fractions of an inch should have a horizontal dividing line (not a slanting dividing line). For example : $\frac{7}{8}''$ Fractions should be complete, thus :

$\frac{5}{6}\frac{7}{4}''$ and not $\frac{7}{8}'' + \frac{1}{6}\frac{}{4}''$

c. Decimals. The decimal point should be bold and should be opposite the middle of the figure, thus :

2·625″

Where the dimension is less than unity, it is recommended that the cipher (0) preceding the decimal point should be omitted on production drawings thus :

·625″

NOTE 1. It is desirable not to mix fractional and decimal dimensions on the same drawing, except, that decimals must be used for dimensions with limits and for chords, gauge numbers, gearing pitches, decimal drill sizes, etc., and for dimensions which cannot be expressed in the usual fractions.

2. Where feet are used as one unit in a dimension, it is preferable to express parts of an inch in fractions, thus :

5′–7½″ and not 5′–7·5″

Where decimals are used, any figures preceding the decimal point should be given in inches and not in feet and inches, thus :

25·42″ and not 2′–1·42″

d. Limiting dimensions. For method of expressing limiting dimensions, see Clause 13.

e. Dimensions which are not to scale should be clearly indicated by the addition of the letters N.T.S. or by underlining.

f. Dimension lines and projection lines should be thin as indicated by type *b* line shown in Fig. 2. Dimension lines may be interrupted at or near their centres for the insertion of dimensions.

Projection lines should commence just clear of the outline of the object, and should extend a little beyond the dimension line. See Fig. 24.

A centre line should never be used as a dimension line.

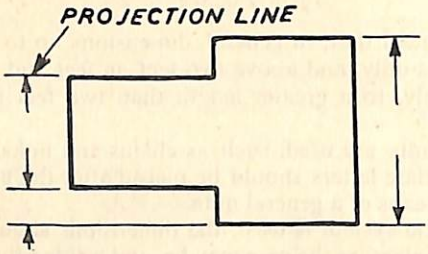


Fig. 24. Illustrating gap between projection lines and outline of object, also extension of projection line beyond dimension line

g. Arrow heads should be a full $\frac{1}{8}$ in. long with a sharp point and partly filled in. The point should touch the projection lines. See Fig. 24.

h. Arrangement of dimensions. In order to obtain clarity all dimensions should be carefully spaced and preferably placed outside the outline of the object.

Sufficient dimensions should be given so that all the parts shown on the drawing can be produced without the necessity of computing dimensions or of scaling. Dimensions should not be duplicated.

Dimensions should generally stand normal to the dimension lines and be written so that they may be read either from the bottom or from the right hand side of the drawing.

In the case of sheet metal work the thickness of material should be clearly indicated and placed either in or near the title block where the material specification is given, or adjacent to the reference or part number.

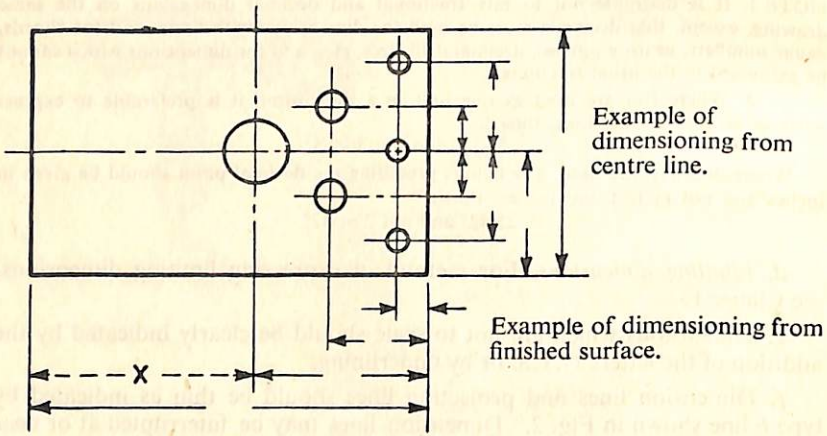


Fig. 25 Dimensioning from basic surface or line

Dimensions should be given from base lines, centre lines, important holes or finished surfaces that can be readily established. See Fig. 25. Overall dimensions should be placed outside the intermediate dimensions. See Fig. 25.

In dimensioning, especially with limits, if an overall dimension is shown, one of the intermediate distances should not be dimensioned. For instance, in the set of dimensions shown at the bottom of Fig. 25, dimension X should be omitted. See examples in Plate 4.

(*i*) *Radii and diameters.* Wherever possible the dimensions of *small* radii should be shown outside the outline of the object. The dimension should be followed by the abbreviation ' rad ' or by the symbol ' R.' Where the centre point of a radius is dimensioned a dot should be placed at the intersection of the lines which locate the centre of the radius in order to prevent errors if other dimension lines are nearby. See Fig. 26.

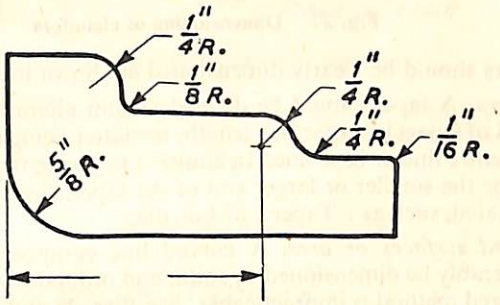


Fig. 26. Dimensioning of radii

Dimensions of diameters should be placed on the most appropriate view to ensure clarity, as for instance, on a longitudinal view in preference to an end view consisting of a number of concentric circles. The dimensions should be followed by the abbreviation ' dia.'

j. Gauge numbers, drill numbers or letters, etc. Thicknesses or diameters indicated by gauge sizes or letters should be followed by the size in decimals of an inch or millimetres, as the case may be, thus: 10 SWG (·128″); No. 55 Drill (·052″ dia.) ; Letter F Drill (·257″ dia.).

k. External and internal threads. The extent of full thread, exclusive of run-out, should be dimensioned. The depth of holes drilled for tapping should be dimensioned where necessary.

l. Countersunk holes and chamfers. For countersunk holes the maximum diameter and the included angle should be given.

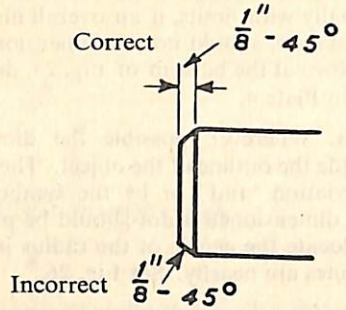


Fig. 27. Dimensioning of chamfers

Chamfers should be clearly dimensioned as shown in Fig. 27.

m. Tapers. A taper should be defined as unit alteration in the diameter or thickness of a part in a specified length, the latter being measured along the geometric centre line or base line. In addition to giving the diameter or thickness at either the smaller or larger end of the taper, the amount of the taper should be stated, such as : Taper 1 in 4 on dia.

n. Curved surfaces or arcs. A curved line composed of circular arcs should preferably be dimensioned by radii, and ordinates should only be used if the preferred method is impracticable. See Figs. 28 and 29.

In dimensioning the spacing of holes and other features on curved parts great care should be taken to indicate clearly on which surface the dimensioned points are to be measured and whether the dimensions are chordal or circular.

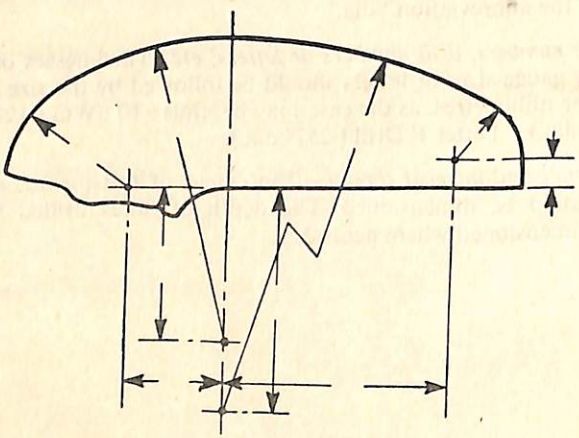


Fig. 28. Dimensioning curves by radii

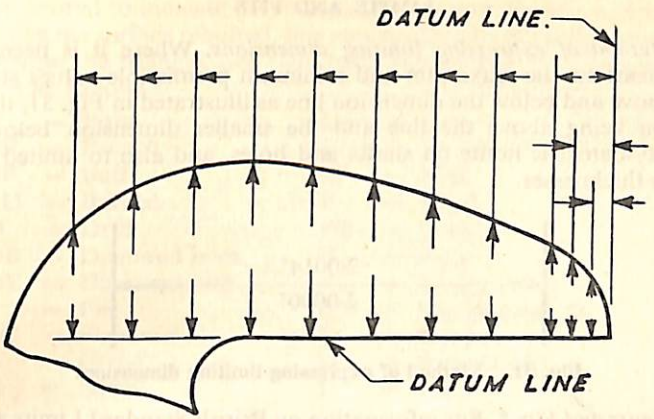


Fig. 29. Dimensioning curves by ordinates

o. Draft or draw. Where draft or draw is required as in drop forgings, mouldings and die castings, part of which may be left unmachined, the draft angle should be shown and stated. See Fig. 30.

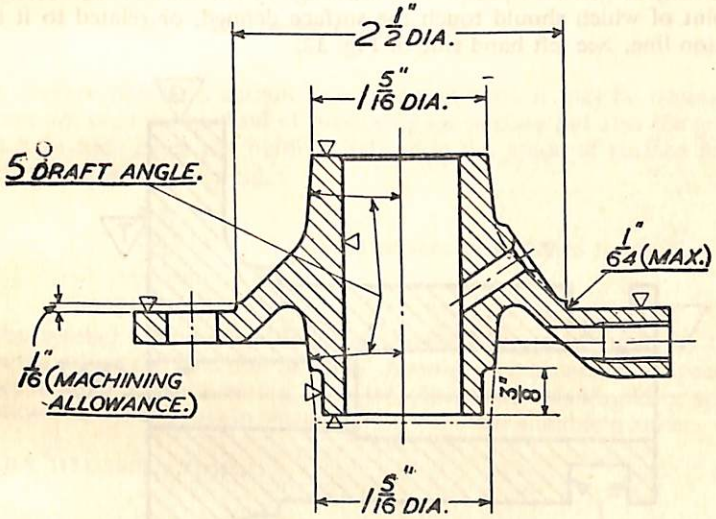


Fig. 30. Draft draw and machining allowances

p. Machining allowances. Normally machining allowances are not shown, but where such allowance is required and is not wholly machined off, it is essential to dimension the extent of the machined portion and to show the remaining portion not machined, i.e., the drawing should represent the actual shape of the completed article. See Fig. 30 where the dimension of $2\frac{1}{2}$" indicates the extent beyond which the flange is to be machined.

LIMITS AND FITS

13. *a. Method of expressing limiting dimensions.* Where it is necessary to limit dimensions the maximum and minimum permissible values should be shown above and below the dimension line as illustrated in Fig. 31, the larger dimension being above the line and the smaller dimension below. This applies to diametric limits on shafts and holes, and also to limited lengths, widths or thicknesses.

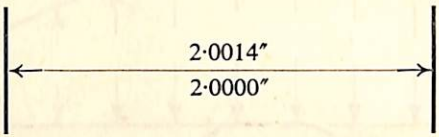


Fig. 31. Method of expressing limiting dimensions

*b. Limits and Fits.** For information on British Standard Limits and Fits, reference should be made to B.S. 164.

MACHINING SYMBOLS AND SURFACE FINISH

14. *a. Machining Symbols.* An indication that a surface is to be machined or finished may be given on production drawings by the use of a small triangle, one point of which should touch the surface defined, or related to it by a projection line. See left hand side of Fig. 32.

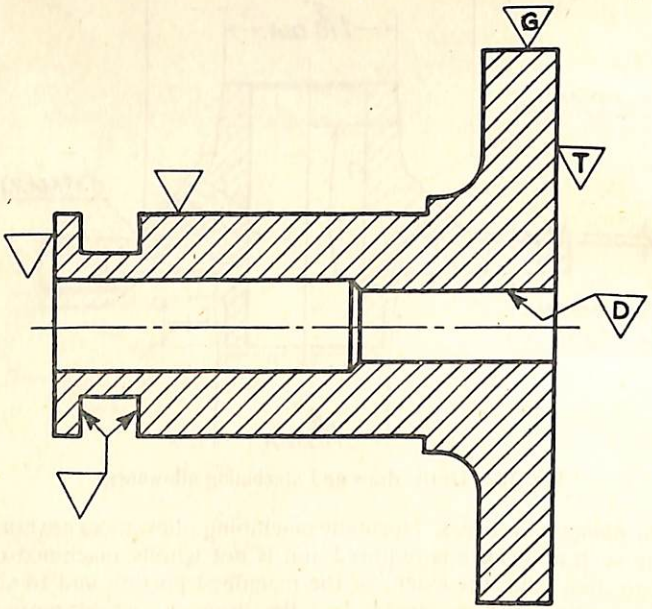


Fig. 32. Machining symbols

* See Foreword.

If it is desired to indicate the machining or other process to be followed in producing the surface required, this may be done by the insertion of a letter symbol within the triangle. See right hand side of Fig. 32. The appropriate letters are as follows :

B	= Bore	LP	= Lap
BR	= Broach	LI	= Linish
BF	= Buff	M	= Mill
BU	= Burnish	P	= Plane
D	= Drill	PO	= Polish
DB	= Diamond bore	R	= Ream
DT	= Diamond turn	RG	= Rough grind
F	= File	RM	= Rough machine
FC	= Flamecut	S	= Scrape
G	= Grind	SF	= Superfinish
H	= Hone	T	= Turn

If all surfaces of a part depicted are to be machined or finished it may be adequate to give one general symbol on the drawing, e.g. :

all over = Machine or finish all over.

all over = Turn all over.

b. Surface finish. In certain high precision work it may be necessary to indicate not only the method of producing the surface but also the grade of finish.* In such cases the number indicating the grade of surface finish is placed over the triangle, e.g. :

= A ground surface of standard finish 32.

The symbol and number indicates that the standard of finish is that measured across the direction of cut of the tool. If it is desired to specify the surface in a particular direction, or in two directions, this should be specifically stated on the drawing in words or in some other suitable manner.

* See B.S. 1134, Surface Finish.

15. *a.* Screw threads of ordinary vee form should be normally indicated by the method illustrated in Figs. 33 (A), 34, 35 and 36.

Instances will occur, in which for clarity and appearance, pictorial representation of screw threads is desirable. For such cases the method illustrated in Fig. 33 (B) is recommended.

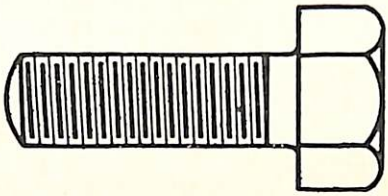


Fig. 33 (B)

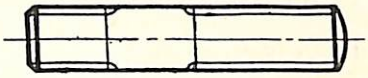


Fig. 33 (A)

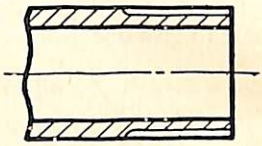


Fig. 34.

External threads

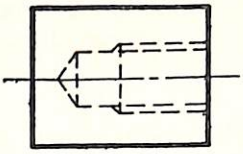


Fig. 35.

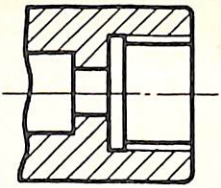


Fig. 36.

Internal threads

b. All threads are assumed to be right hand unless otherwise stated. With right hand threads, it is, therefore, unnecessary to state this on drawings. Left hand threads must be clearly stated, usually by the abbreviation L.H.

c. An assembly view embodying a stud should show the clearances at A and B, Fig. 37. Dimensions to ensure these clearances should be given.

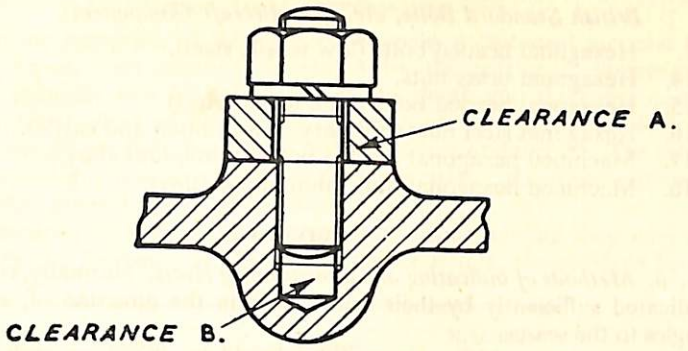


Fig. 37. Clearance for studs

d. Nuts, bolt-heads, screw-heads and washers should be drawn in accordance with the dimensions given in the standard specification governing each type, a list of which is given below.

British Standard Bolts and Nuts, etc.

B.S. 28. Dimensions of B.S. Whit. Black Bolts and Nuts, Studs, Lock Nuts and Washers.

B.S. 916. War Emergency dimensions of Black Bolts, Nuts and Lock Nuts (small hexagon and square B.S. Whit. and B.S. Fine).

B.S. 190. Dimensions for B.S. Whit. Bright Hexagon Bolts, Set-screws and Nuts, Split Pins, Washers and Studs.

*B.S. 325. Dimensions of Black, Iron and Steel, Cup and Countersunk Bolt-heads, Nuts and Washers.

B.S. 450. Bright Countersunk, Round and Cheese Head, Screws (B.S. Whit. and B.S. Fine.)

B.S. 451. Bright Square Head Set-screws (with Flat Chamfered Ends) (B.S. Whit. and B.S. Fine).

B.S. 1083. Bolts, Nuts and Set-screws (machine bolts) (B.S. Whit. and B.S. Fine).

B.S. 84. Screw Threads of Whitworth Form.

B.S. 57. Heads for British Association Screws.

B.S. 93. British Association Screw Threads with Tolerances for Sizes No. 0 to 15 B.A.

B.S. 811. Cycle Threads (formerly known as C.E.I. Threads).

B.S. 1095. Metric Screw Threads, Système International.

B.S. 1104. General Purpose Acme Screw Threads.

* The method shown in B.S. 325 for indicating the square part of the shank of bolt-heads by fine crossed lines, should be adopted only for indicating squared sections forming part of an otherwise round spindle.

British Standard Bolts, etc., for Aircraft Components.

A1. Hexagonal headed bolts (low tensile steel).
A14. Hexagonal brass nuts.
A15. Hexagonal headed bolts (high tensile steel).
A16. Hexagonal steel nuts (ordinary, thin, slotted and castle).
A17. Machined hexagonal headed bolts (aluminium alloy).
A18. Machined hexagonal nuts (aluminium alloy).

RIVETS

16. *a. Methods of indicating and dimensioning rivets.* Normally, rivets may be indicated sufficiently by their centre lines in the direction of, and at right angles to the seams.

In long seams a few rivets only should be shown at each end. Intermediate rivets should be omitted and the centre lines of the rivet rows only, in the direction of the seam, should be shown.

Methods for dimensioning the pitch of rivets are given in Clause 18.

b. Rivet Symbols. Where it is advantageous to use symbols and there is a possibility of misunderstanding, a key to the symbols should be shown.

c. British Standard Specifications for rivet forms and dimensions are listed below.

Description	Rivets in general excluding boiler rivets		Boiler rivets
	Girder bridges	Structural steel in building	
Diameters of rivets	B.S. 275	B.S. 275	B.S. 425
Forms of rivet heads	B.S. 275	B.S. 275	B.S. 425
Rivet spacing	B.S. 153 Part 4	B.S. 449	B.S. 537
Tacking rivets		B.S. 449	
Weight of rivet heads	B.S. 153 Part 2		

Dimensions of small rivets for general purposes : B.S. 641.

For rivets used in the aircraft industry reference should be made to the appropriate publications of the Society of British Aircraft Constructors.

WELDING

17. Standard methods for indicating welds on drawings by means of symbols are given in the Appendix to B.S. 499, Nomenclature, Definitions and Symbols for Welding and Cutting.

STRUCTURAL STEELWORK

18. *a.* With the exception of beams and channels, rolled steel sections for structural purposes are usually designated by the sectional dimensions. Beams and channels may be designated by the depth and thickness of the web and nominal width of flanges, or by depth of web, nominal width of flanges and weight per foot, but not by both thickness and weight. The latter method, i.e., designation of weight per foot, represents the more common practice in the case of beams and channels.

Where sections of various kinds are shown on a drawing they may be designated by the following symbols or reference letters, the symbols being preferred :

Section	Symbol	Reference letters
Beam	⌶	B.S.B.
Channel	[	B.S.C.
Angle (equal)	L	B.S.E.A.
(unequal)	L	B.S.U.A.
Tee	T	B.S.T.
Bulb angle	L	B.S.B.A.
Bulb plate	∣	B.S.B.P.

b. Typical examples.

Beam	18″ × 6″ × 55 lb.	⌶	or	18″ × 6″ × 55 lb. B.S.B.
Channel	17″ × 4″ × 44·34 lb.	[	or	17″ × 4″ × 44·34 lb. B.S.C.
Angle	3″ × 3″ × $\frac{3}{8}$″	L	or	3″ × 3″ × $\frac{3}{8}$″ B.S.E.A.
Tee	6″ × 3″ × $\frac{1}{2}$″	T	or	6″ × 3″ × $\frac{1}{2}$″ B.S.T.
Bulb Angle	7″ × 3$\frac{1}{2}$″ × 15·3 lb.	L	or	7″ × 3$\frac{1}{2}$″ × 15·3 lb. B.S.B.A.
Bulb Plate	10″ × $\frac{1}{2}$″ × 25·66 lb.	∣	or	10″ × $\frac{1}{2}$″ × 25·66 lb. B.S.B.P.

Compound sections :

Column :	3/24″ × 7$\frac{1}{2}$″ × 95 lb. 2/24″ × 1″ Pl. 2/24″ × $\frac{1}{2}$″ Pl.	⌶	or	3/24″ × 7$\frac{1}{2}$″ × 95 lb. B.S.B.
Girder :	4/6″ × 6″ × $\frac{1}{2}$″ 2/16″ × 1″ Pl. 2/16″ × $\frac{1}{2}$″ Pl. 1/66″ × $\frac{1}{2}$″ Web Pl.	L	or	4/6″ × 6″ × $\frac{1}{2}$″ B.S.E.A.

Where proprietary sections are to be specified on drawings, they should be described by the full trade designation as nearly as possible in accordance with the above.

Where all the sections shown on a drawing are beams, for example, the symbol and reference letters may be omitted always provided that a note be added stating that unless otherwise indicated all sections are B.S.B. (British Standard Beams).

c. Pitch of rivets or bolts. A series of equal pitches should be dimensioned, as in Figs. 38 and 39 by giving the number of pitches, the pitch and the distance so covered.

Where the pitch is given as the distance between adjacent rivets or bolts in two or more rows, at least one pitch should be dimensioned at one end.

d. Holes. Full particulars should be given for specifying holes, as in the following typical examples, viz. :

(i) $\frac{15}{16}''$ holes for $\frac{7}{8}''$ field rivets.
(ii) $\frac{13}{16}''$ holes for $\frac{3}{4}''$ bolts.
(iii) Field holes are for $\frac{3}{4}''$ bolts.

Where it is necessary to draw details to a small scale, areas representing holes may be blackened for clearness.

e. Dimensions of members. Sectional dimensions and lengths of principal members, gusset plates, brackets, cleats, etc., should be given in close proximity to the members to which they refer, Fig. 38, or to the item numbers or letters for these members, Fig. 39.

f. Inclination. Where necessary, to facilitate marking-off, inclination should be given, as shown in Fig. 38, by means of a triangle.

g. Indication of accuracy. The degree of accuracy required may be indicated as in the following examples, viz. :

a. $1/24'' \times 7\frac{1}{2}'' \times$ 100 lb. B.S.B $\times$ 19′–11$\frac{3}{4}''$ Exact.
b. 1 Column, marked 1, 15′–17$\frac{1}{2}'' \pm \frac{1}{16}''$
c. 1 Column, marked 2, 23′–7$\frac{9}{16}''$ Milled ends.

h. Marking Plans. Normally, marking plans should give only main dimensions and numbers or letters for referring to lists and details. A typical example is shown in Fig. 40. The stanchions are numbered first, and these numbers are used as prefixes to the beam numbers in the bay to the east and to the north of the particular stanchion. As there are no external stanchions in the example illustrated, the beams in the extreme western and southern bays have the same prefix numbers as the beams to the east and to the north of the respective stanchions.

Numbers ending in 1, 2, 3 and 4 are only to be used for beams connected to stanchions.

Beams running north and south are given odd numbers, and those running east and west are given even numbers.

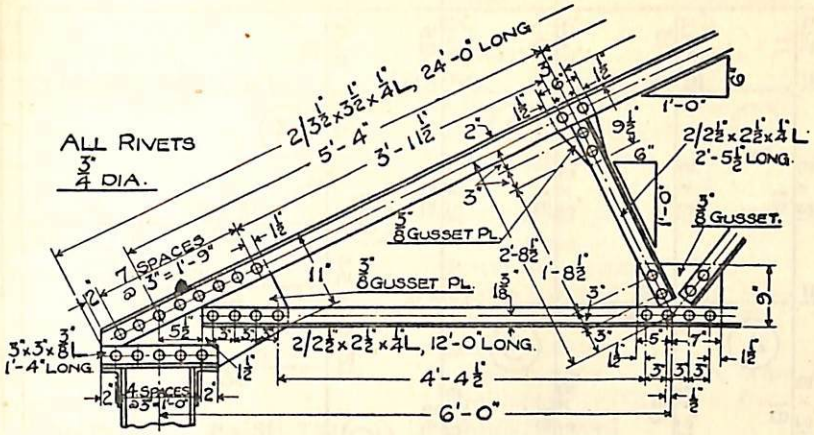


Fig. 38. Portion of arrangement drg. embodying details

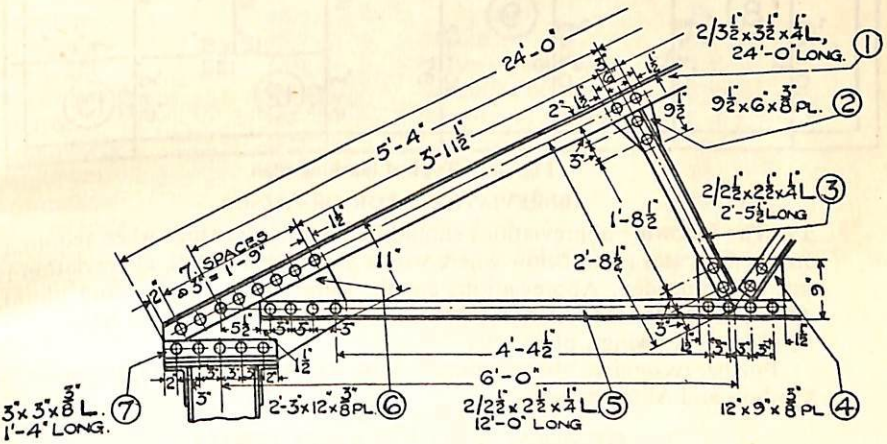


Fig. 39. Portion of arrangement drg. embodying details and item Nos.

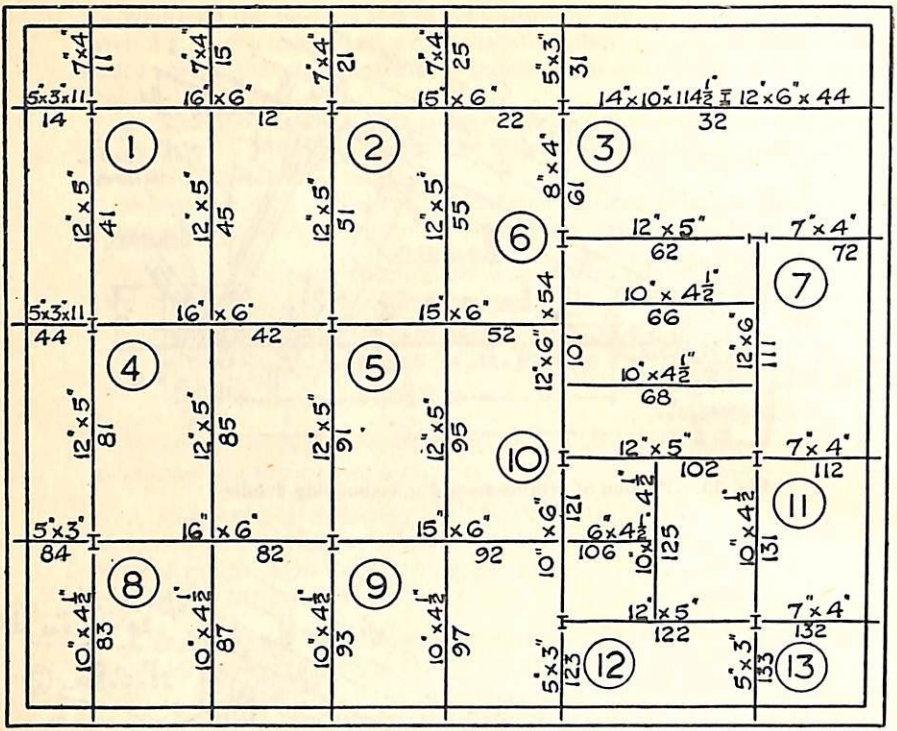


Fig. 40. Typical marking plan

ABBREVIATIONS FOR DRAWINGS

19. The following abbreviations should be used on drawings when required In the few cases given below where words are written in full, abbreviation is not recommended. Abbreviations are the same in the singular and plural. Although lower case letters are generally recommended, capital letters may be used on drawings, plans, etc.

Further recognised abbreviations are listed in B.S. 560 : 1934, Engineering Symbols and Abbreviations.

GENERAL ENGINEERING TERMS

Terms	Abbreviations	Terms	Abbreviations
Annealed	ann.	Chamfered	chamf.
Approved	appd.	Checked	ckd.
Approximate	approx.	Cheese head	ch.hd.
Birmingham gauge	B.G.	Circular pitch	C.P.
Brinell hardness number	B.H.N.	Circumference	circ.
British Standard	B.S.	Corrugated	corr.
Case hardened	C.H.	Countersunk	csk.
Centimetres	cm.	Counterbore	cbr.
Centre line	C.L. or ℄	Cube or cubic	cu.
Centre to centre	C. to C.	Cylinder or cylindrical	cyl.

Terms	Abbreviations
Diameter	dia.
Diametral Pitch	D.P.
Diamond pyramid hardness number	D.P.N.
Drawing	Drg.
Extruded	extd.
Figure	Fig.
Foot or feet	ft. (or ′)
Galvanised	galv.
Ground Level	G.L.
Hard drawn	H.D.
Hardened and tempered	h. & t.
Hexagon	hex.
Hydraulic	hyd.
Imperial (Standard) Wire Gauge	S.W.G.
Inch or inches	in. (or ″)
Insulated or insulation	insul.
Kilogram	kg.
Left Hand	L.H.
Machine	M/c.
Machinery	M/cy.
Material	Mtl.
Maximum	max.
Metres	m.
Millimetres	mm.
Minimum	min.
Normalised	norm.
Not to scale	N.T.S.
Number	No.
Pattern Number	Patt. No.
Per	/
Pitch Circle	P.C.
Plan	Pl.
Pneumatic	pneu.
Pound	lb.
Radius	rad. or R.
Revolutions per minute	r.p.m.
Right Hand	R.H.
Round	rd.
Round Head	Rd. Hd.
Screw Threads :	
British Association	B.A.
British Standard Fine	B.S. Fine
British Standard Pipe	B.S. Pipe
British Standard (Whitworth)	B.S. Whit.
British Standard Cycle	B.S. Cyc.
British Standard Conduit	B.S. Cond.
Système International	S.I.
Screwed	scr.
Sheet, when preceding a material	Sh.
Sketch	Sk.
Sluice or stop valve	S.V.
Specification	Spec.
Spigot and socket	s. & s.
Spot faced	Sp. F.
Square	sq.
Square inch	sq. in.
Standard	std.
Threads per inch	t.p.i.
Tinned	Tinned
Traced	Tcd.
Weight	wt.

MATERIALS

Metals (ferrous)	Abbreviations
Cast iron	C.I.
Malleable cast iron	M.C.I.
Sheet iron	Sh.I.
Wrought iron	W.I.
Steel (when the word is used by itself without qualification)	Steel
Cast steel	C.S.
Forged steel	F.S.
High tensile steel	H.T.S.
High tensile welding steel	H.T.W.S.
Manganese steel	Mang. S.
Mild steel	M.S.
Nickel chromium steel	Ni. Cr. S.*
Nickel steel	Ni. S.*
Sheet steel	Sh. S.
Spring steel	Spring S.

* Other alloy steels may be represented in a similar manner.

Metals (non-ferrous)	Abbreviations	Metals (non-ferrous)	Abbreviations
Aluminium	Al.	Lead	Ld.
Aluminium bronze	Al.B.	Manganese bronze	Mang. B.
Brass	Br.	Naval brass	N. Br.
Bronze (without qualification)	Bronze	Phosphor bronze	Phos. B.
		Platinum	Pt.
Copper	Cpr.	Tin	Tin
German silver	Ger. Sil.	White metal	W.M.
Gunmetal	G.M.	Zinc	Zn.

NON-METALLIC MATERIALS

Asbestos	asb.	India rubber	I.R.
Bitumen	bitn.	Porcelain	porc.
Carbon	carb.	Vulcanised fibre	V.F.

GRAPHS

20. *a.* Graphs are used whenever they can illustrate the relation between variable factors to greater advantage than numerical tables, and may take the form of bar graphs, single line graphs, multiple line graphs, progress diagrams or charts, etc.

b. The paper used for drawing graphs is generally ruled in squares of 10 divisions to the inch with heavier lines dividing the sheet into one inch or half inch squares. In special cases the paper may be ruled with logarithmic divisions in one or both directions.

c. Wherever possible the scales should be chosen so that one inch or one-half inch represents 1, 10, 100 units, etc., as may be convenient, but the first consideration should in all cases be that the scale chosen should be suitable for the purpose for which it is to be used. In particular, it is important to note that suitable scales can accentuate the curvature of an otherwise flat curve, and thus facilitate recognition of its true form.

Normally, the horizontal scale should be along the bottom of the paper, and the vertical scale should be on the left. Where multiple scales are used, it is frequently advantageous to use the top and right hand sides for other scales.

d. With the arrangement of scales normally used, the zero is in the bottom left hand corner with positive values reading upwards and to the right. Where it is not possible or desirable to show complete values from zero to a maximum a distinct break should be shown.

e. The lines should be thick and outstanding in appearance with the centre of the line representing the value. When plotting points determined experimentally, the values of each point should be shown and should be suitably marked with a dot surrounded by a geometric figure. The graph line should then be drawn through the mean of all the points obtained unless adequate reason exists for neglecting certain doubtful values.

Where the graph represents a formula or an empirical relation which may be expected to be continuous, the line should be drawn smoothly ; in cases where a line is drawn from point to point of a discontinuous function, a series of straight lines should be used to join the points, or a bar graph may be drawn.

f. Sector graphs or other special forms may be used to represent particular relationships where greater clarity is thus obtained.

g. The lettering used should be arranged horizontally to read from the bottom of the sheet as far as practicable, but where preferred the nomenclature of a curve or graph line may be written along the line.

h. The data on which a graph is based should be given whenever possible.

i. Hatching, shading or colouring may be used where required to distinguish component parts, or for emphasis.

j. Typical examples of graphs are shown in Fig. 41.

APPENDIX I

REPRODUCTION OF DRAWINGS

It is generally undesirable that original drawings and tracings should be employed for use in workshops and the production of satisfactory prints is particularly important for remote factories or parts to be manufactured by other organisations.

The types of prints which can be easily produced by the usual industrial contact photo print equipment are as follows :

1. Ferro-prussiate or blue prints on paper, mounted paper and opaque cloth, water washed or by semi-dry development.

2. Dye line prints by semi-dry development, giving commonly a brown or black line on a white background, on paper, mounted paper, opaque cloth, translucent paper or translucent cloth.

3. Ammonia gas dry-developed prints (another form of dye line print) giving results similar to (2) including also a blue line.

4. Ferro-gallic prints on paper, mounted paper and opaque cloth giving an indigo-black line on a white background. These prints have been largely superseded by those under (2) and (3).

5. Sepia prints on paper giving a white line on a dark brown background. These are made on thin paper to be employed generally as negatives for further reproduction ; used with ferro-prussiate paper they then yield blue lines on a white background.

(1), (2) and (3) are the prints most commonly in use.

Other types of prints are in use which require equipment employed by photo print trade houses and certain industrial establishments where the demand for these prints warrants its installation. These include :

6. ' True to Scale ' prints, which have a black ink line on a natural (unsensitised) background of paper, mounted paper, tracing paper, opaque and tracing cloth. Being carbon ink lines on natural unsensitised material these prints do not fade or deteriorate ; they are also more true to scale, better for colouring and not easily distinguishable from hand made drawings or tracings. This process also has the advantage that additions and omissions are possible during the printing process leaving no trace on the finished print ; in the same way creased and soiled originals can have these disfigurements largely eliminated from the prints.

7. *Bromide Prints.* In addition to the contact methods of reproduction described above, the camera in various forms is frequently used to make copies on film, paper, translucent paper and cloth. Original drawings, prints, including blue prints, maps, etc., which are on opaque material and cannot, therefore, be readily copied by other processes can be reproduced in this way. For urgent production original pencil drawings if sufficiently well finished in detail for workshop use can be copied by this process, thus eliminating the preparation of tracings. In such cases the draughtsman's time to finish the originals in this way and the higher cost of prints must be set off against the saving in tracers' time. For well finished permanent

records of important drawings ink tracings are recommended. The bromide print process enables enlargements and reductions to be made and special apparatus is available for the rapid production of reduced size prints for convenience and safety in storing and transport ; these reductions may be enlarged when required for use.

8. Reflex prints can be made on paper, translucent paper and cloth. Copies can be made by this process of opaque originals as under (7) but being a contact process enlargements and reductions are not obtainable. Reflex print apparatus of various makes is available and as in the case of bromide prints this process is much used for general document copying.

Translucent prints for multiple production in various factories. It is recommended that for multiple production of the same mechanism or part in various factories consideration should be given to ease of producing prints by all firms concerned. For this purpose the designing firm should provide prints on translucent material which will serve as original tracings from which further prints can easily be made by the various firms concerned in the production of the articles, employing the usual industrial contact photo print equipment. In the event of alterations to the design it is preferable for the designing firm to supply a complete new translucent print in the way described. The supplying of opaque prints only, leads to delays and mistakes and frequently the despatching of many copies.

Prints on translucent material can be supplied by the following processes :

' *True to Scale* ' *Process.* Excellent full size copies (prints) on tracing paper or tracing cloth which are almost indistinguishable from hand drawn ink tracings can be supplied by this process. The several advantages of this process are described above under (6) and this is the only process which in its intermediate stage permits the easy elimination of crease marks and other undesirable features from the resulting translucent copy.

Semi-dry dye line and ammonia gas developed processes. Both these processes, see (2) and (3) above, will yield full size copies (prints) on tracing paper and tracing cloth, sensitised for the purpose, using the normal industrial contact photo printing equipment. To obtain translucent copies from which satisfactory prints can be made it is essential that the original tracings should have lines of good density and clean background and that great care should be taken to obtain the correct exposure and careful development.

Sepia, Bromide and Reflex Processes. Translucent copies can be obtained by these processes as described under (5), (7) and (8) above.

APPENDIX II

THE PREPARATION AND CARE OF DRAWINGS, TRACINGS AND SENSITISED MATERIALS

a. Materials. Good quality drawing paper is recommended for original drawings, the main criteria being a suitable firm drawing surface that will withstand erasure and toughness to resist tearing. Detail paper, if used over a sheet of drawing paper, is a practical medium for scheming and for original drawings which are not required to withstand considerable erasure and handling ; but if translucency is required so that prints may, if necessary, be taken direct from the originals a good quality natural tracing paper or ' rag-base ' prepared tracing paper should be used. The surface of the paper should be unglazed so that firm dense pencil lines can be easily drawn upon it to give good reproduction.

Pencil tracing cloth with a surface specially prepared for pencil is also a suitable medium for the preparation of original drawings from which prints may be taken direct.

For tracings, when it is not desired to use tracing cloth, the use of natural or ' rag-base ' prepared tracing paper with maximum translucency consistent with toughness is recommended for durability. For quality and permanence the use of ink tracings and not pencil tracings is strongly recommended, particularly when large numbers of reproductions are required ; for the same reasons, if pencil tracings are employed, the surface of the paper should be such that firm dense pencil lines can easily be drawn upon it. When prints are to be made from pencil work it is a common practice to employ Indian ink for the dimension figures, arrow heads and lettering to ensure clear reproduction of these important features.

b. Preparation. Care should be taken in cutting and trimming sheets, as any irregularity of the edges is frequently the cause of tearing when sheets are in use.

It is recommended that the larger sheets of paper and particularly tracing paper and tracing cloth should be stretched and pinned down for several hours, preferably overnight, then released and re-pinned before use. This allows the sheet to settle down and reduces the tendency to distortion after the work on the sheet has been commenced. This is essential when using large sheets of tracing cloth. It is recommended that all tracing work should be progressive from one corner of the sheet and this is particularly important when the tracing is on the drawing board overnight during changing weather conditions affecting the humidity of the atmosphere. It is also desirable to endeavour to complete the tracing of any one view before leaving the tracing overnight.

Tracing cloth, after stretching, should be treated with finely powdered chalk, applied with a clean soft cloth. This removes any traces of greasiness and greatly facilitates the drawing of even, dense ink lines. More than one application may be necessary during the tracing and the residue of chalk powder should always be carefully wiped off.

c. Storage. In order to avoid damage and waste, all papers and cloths should be stored :—

(i) In well ventilated rooms away from damp and heat.

(ii) Unused rolls, if in large quantities, should be stored on end.

(iii) Because of deterioration with age, storing receptacles for unused materials, particularly sensitised materials and tracing papers, should have at least two compartments, so that fresh deliveries are kept separate until the material longest in stock has been used. Storing receptacles for sensitised materials should exclude light, particularly for rolls and sheet packages which have been opened ; rolls will keep satisfactorily longer than cut sheets.

(iv) The wrapping of rolls and sheets should not be removed until the material is about to be used. If only part is required the wrapping should be replaced or in the case of sensitised paper and cloth part-used rolls may be stored in metal or cardboard tube containers with tight fitting lids.

(v) When drawers are used for storing sheets or tracings they should be provided with a strip fitted at the rear of each drawer which prevents the sheets curling inside the drawer and becoming damaged. Some plan cabinets are obtainable with a similar but hinged strip at the front of the drawer which serves the same purpose at the front.

(vi) All drawings, tracings and prints which have been damaged or torn in use should be repaired before being re-filed to prevent extension of the damage.

(vii) In planning storage for important drawings and tracings consideration should be given to safety. It may be advisable to have a complete set of copies (full sized or reduced) stored safely in an area well away from the works and offices. The various methods of producing such copies are described in Appendix I, ' Reproduction of Drawings.'

APPENDIX III

BRITISH STANDARDS FOR MATERIAL SPECIFICATIONS AND GENERAL ENGINEERING

As stated in Clause 3 c. (i) raw material from which parts are to be made should be clearly specified and the number of the relevant British Standard or other accepted specification quoted. Where necessary, the grade of the particular material should also be indicated.

A list of British Standard Specifications for materials now available is too lengthy for inclusion here, and reference should therefore be made to the B.S.I. Yearbook or the Sectional Lists of British Standards. The following B.S.I. publications, which include details of ferrous and non-ferrous metals, should also be of assistance.

B.S. 970. Wrought Steels in the form of Bars, Billets, Light Forgings and Stampings up to 6 in. Ruling Section for General Engineering Purposes (En Series 1–58).

B.S. 971. Wrought Steels (Carbon and Alloy Steels) T.A.C. 1–33.

B.S. 991. Data on Cast Iron.

B.S./STA.5. Services Schedule of Carbon and Alloy Steels for Armaments and Vehicles.

B.S./STA.7. Services Schedule of Non-Ferrous Metals and Alloys for Armaments and General Engineering Purposes.

B.S. 1007. Summary of British and American Standard Specifications for Non-Ferrous Metals.

B.S. 1111. Summary of British and American Standard Specifications for Iron and Steel.

GENERAL ENGINEERING STANDARDS

a. Rolled steel sections for structural purposes.

Sections	British Standard
Channels and beams	4
Equal angles, unequal angles and T bars	4 A
Bulb angles and bulb plates	6

b. Rails, fishplates, etc.

Type	Rails	Fishplates	Fishbolts
Bull head railway	B.S. 9	B.S. 47	B.S. 64
Flat bottom railway (R series)	B.S. 11	B.S. 47	B.S. 64
Light flat bottom railway	B.S. 536	B.S. 536	
Light railway for use in mines (M series)	B.S. 248	B.S. 248	
Light and heavy bridge type railway	B.S. 105		
Tramway and dock	B.S. 2	B.S. 2	

c. Pipes.

Material and purpose	Type of joint		
	Spigot and socket	Flanged	Union or Rebated
Asbestos cement :			
Flue pipes for domestic stoves	B.S. 835		
Flue pipes for gas fired appliances	B.S. 567		
Rainwater pipes	B.S. 569		
Soil, waste and ventilating pipes	B.S. 582		
Pressure pipes			B.S. 486
Cast Iron :			
Drain pipes	B.S. 437		
Flue or smoke pipes	B.S. 41		
Gas, sewage, water pipes	B.S. 78	B.S. 78	
Heating pipes (low pressure)	B.S. 40		
Rainwater (heavy) soil, ventilating and waste pipes	B.S. 416		
Rainwater (light) cylindrical	B.S. 460		
Hydraulic pipes		B.S. 44	
Concrete pipes	B.S. 556		B.S. 556
Salt glazed ware pipes	B.S. 65		
Salt glazed glass (vitreous) enamelled fireclay pipes	B.S. 540		
Fittings for salt glazed ware and salt glazed glass (vitreous) enamelled fireclay pipes	B.S. 539		
Steel pipes	B.S. 534		B.S. 879
Pipe flanges		B.S. 10	
Pipe threads			B.S. 21

d. For a complete list of dimensional Standards, or Specifications comprising dimensional standards, reference should be made to the latest B.S.I. Lists of Standards, published separately and in the Yearbook of British Standards. Many of these Standards are also included in the B.S. Handbook No. 2, British Standards for Workshop Practice.

APPENDIX IV. SYMBOLS

Description	Publication
a. Electrical Symbols.	
Graphical Symbols for General Electrical Purposes	B.S. 108
Graphical Symbols for use in connection with Interior Electrical Installations	B.S. 447 (included also in B.S. 108)

Description	Publication
Letter Symbols for use in Electrotechnics	B.S. 423 (included also in B.S. 560)
Graphical Symbols for Telephony, Telegraphy and Radio Communication	B.S. 530
Terminal Markings for Electrical Machinery and Apparatus	B.S. 822
Graphical Symbols for Heavy Current Systems	*I.E.C. 35
Graphical Symbols for Weak Current Systems	I.E.C. 42
b. Engineering Symbols.	
Engineering Symbols and Abbreviations	B.S. 560
c. Symbols for Steam Turbine Plant.	
Test Code for Acceptance Tests for Steam Turbines	B.S. 752 (Appendix B)
d. Chemical Plant.	
Symbols for use on Diagrams of Chemical Plant	B.S. 974
e. Chemical Symbols.	
Chemical Symbols and Abbreviations	B.S. 813

* Publications of the International Electrotechnical Commission.

APPENDIX V

† FROM ORDNANCE SURVEY CONVENTIONAL SIGNS

ENGINEERING SURVEY PLANS, LINES AND TOPOGRAPHICAL SYMBOLS

BOUNDARIES

Counties	Parliamentary boroughs (Parly. Boro. Bdy.)		
County & civil parish	Municipal boroughs (Munl. Boro. Bdy)		
Ridings	Municipal wards (Ward. Bdy.)		
County borough (Co. Boro. Bdy.) (England)	Urban districts (U.D. Bdy.)		
County burghs (Co. Burgh. Bdy.) (Scotland)	Police burghs (Scotland) (Burgh. Bdy.)		

† By permission of the Controller of H.M. Stationery Office.

Parliamentary county divisions — Parly. Div. Bdy. — Rural districts — R.D. Bdy. — Civil parishes

Divisions of parliamentary boroughs — Div. of Parly. Boro. Bdy.

BOUNDARIES IN CONNECTION WITH STREAMS, HEDGES, ETC.

Centre of stream — C.S. — C.S.

Centre of track of stream — C.Tk.S. — Tk.S

Centre of road — C.R.

Side of stream or drain — S.S.

Side of stream ; drain or stream straight, boundary changes sides — S.D. — S.D.

Side of stream ; boundary straight, stream or drain changes sides — S.S. — S.S.

Track of hedge — Tk. H. — Tk. H.

Root of hedge, face of cop, side of fence — R.H. — R.H.

Face of wall — F.W.

4 ft. from root of hedge or fence, etc. — 4 ft. R.H.

,, ,, Fence straight, boundary change sides — 4 ft. R.H. — 4 ft. R.H.

,, ,, Boundary straight, fence changes sides — 4 ft. R.H. — 4 ft. R.H.

,, ,, Stream on the boundary side of fence — 4 f.t. R.H.

,, ,, Boundary straight, fence changes sides — 4 ft. R.H. — 4 ft. R.H.

Centre of fence, top of cop, centre of wall, etc. — C.F. — T.C. — C.W.

Defaced or undefined, track of stream, drain or fence — Def. — Tk. S. — Und.

CONVENTIONAL SIGNS

Electricity pylon	. E.P. or ⊡ E.P.	Foot bridge	F.B.
Telephone call box	. T.C.B.	Foot path	F.P.
Police call box	. P.C.B.	Bridle road	B.R.
Mile stone	. M.S.	Site of antiquities	∘┼∘
Pump	. P		
Signal post	. S.P.	Arrow denotes flow of water	←≪
Guide post or board	. G.P.	High or low water mark of medium tides	H. or L.W.M.M.T. (England)
Letter box	. L.B.	High or low water mark Ordinary spring tides	H. or L.W.M.O.S.T. (Scotland)
Trigonometrical station	△		
Altitude of trigl. station	507 △	Sluice	Sl.
		Trough	Tr.
Bench mark	B.M.325·9 ↑	Spring	∘ Sp.
Surface level	342 +	Well	∘ W
Boundary stone	∘ B.S.	Mooring ring	. M.R.
Boundary post	∘ B.P.	Mooring post	. M.P.

Land areas and numbers included in the same reference :

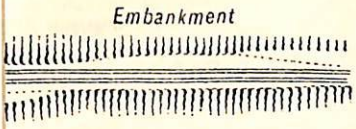
(*a*) track excluded

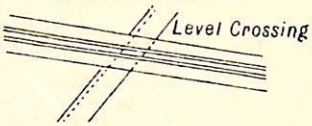
(*b*) track included

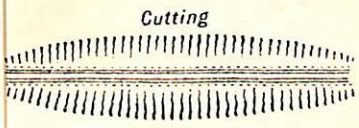
DRAWING OFFICE PRACTICE

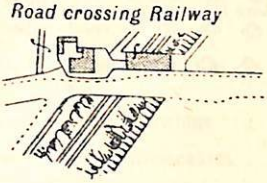
ENGINEERING SURVEY PLANS

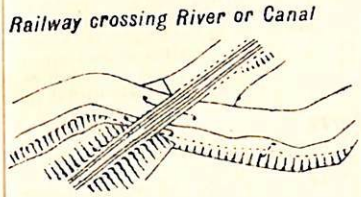
Conventional signs

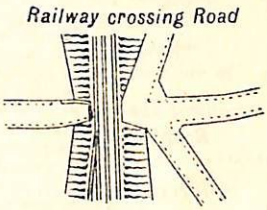


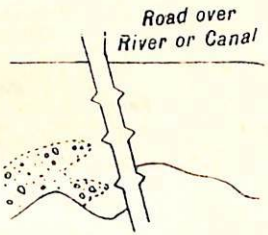


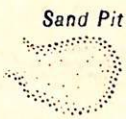








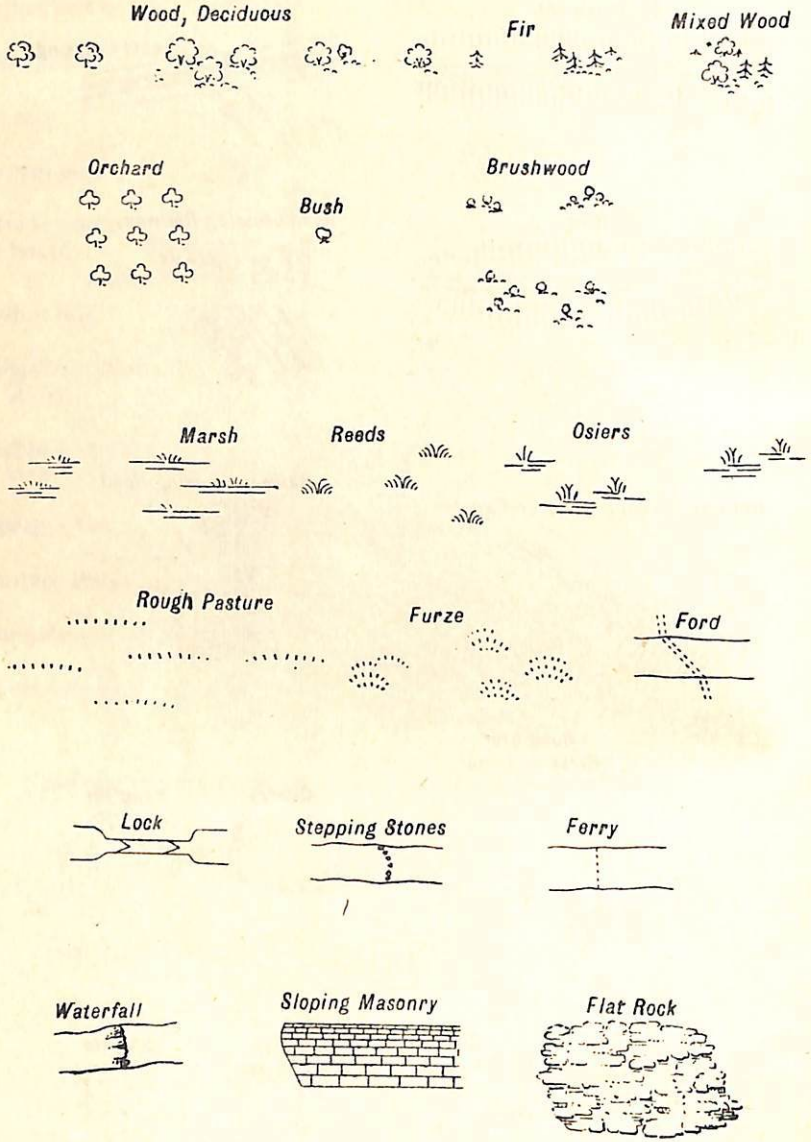




DRAWING OFFICE PRACTICE

ENGINEERING SURVEY PLANS

Conventional signs



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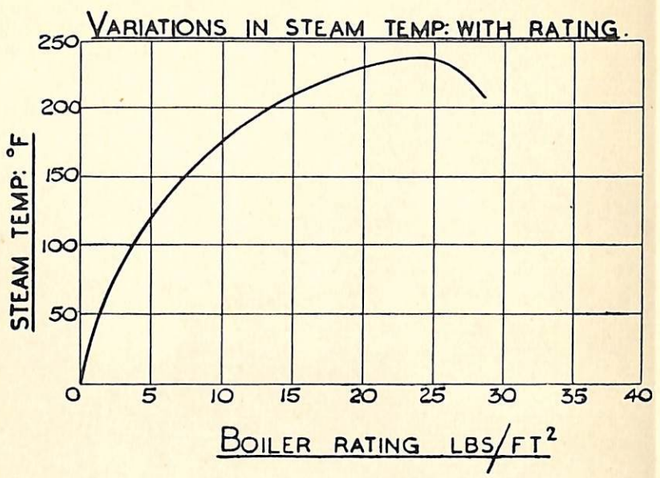
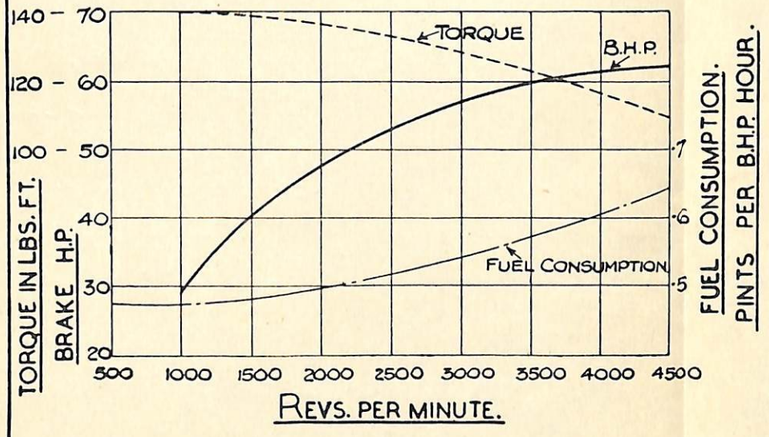


SINGLE LINE TECHNICAL CURVE.



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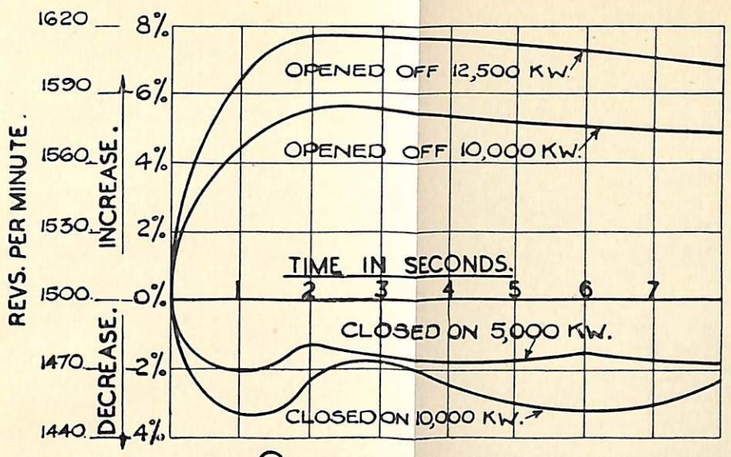
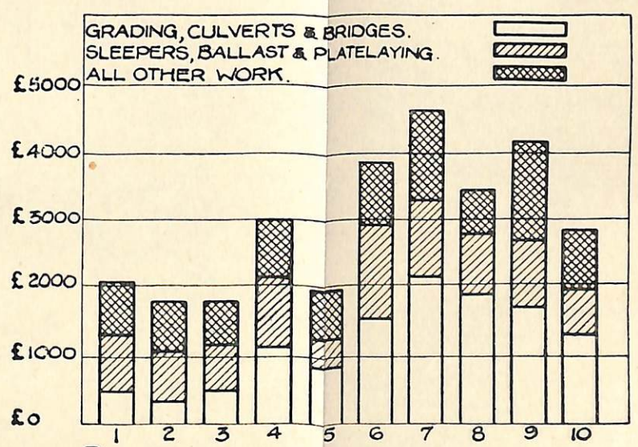


GOVERNOR CHARACTERISTICS.

CURVES ABOVE & BELOW A COMMON MEAN.



COST OF RAILWAY CONSTRUCTION.

BAR GRAPH.

FIG: 41. GRAPHS.

DRG. OR PART Nº

DO NOT SCALE. REMOVE ALL BURRS & SHARP EDGES.

ALTERATIONS.			
Nº OR LETTER	NOTE Nº	ALTERATION	SIG. & DATE

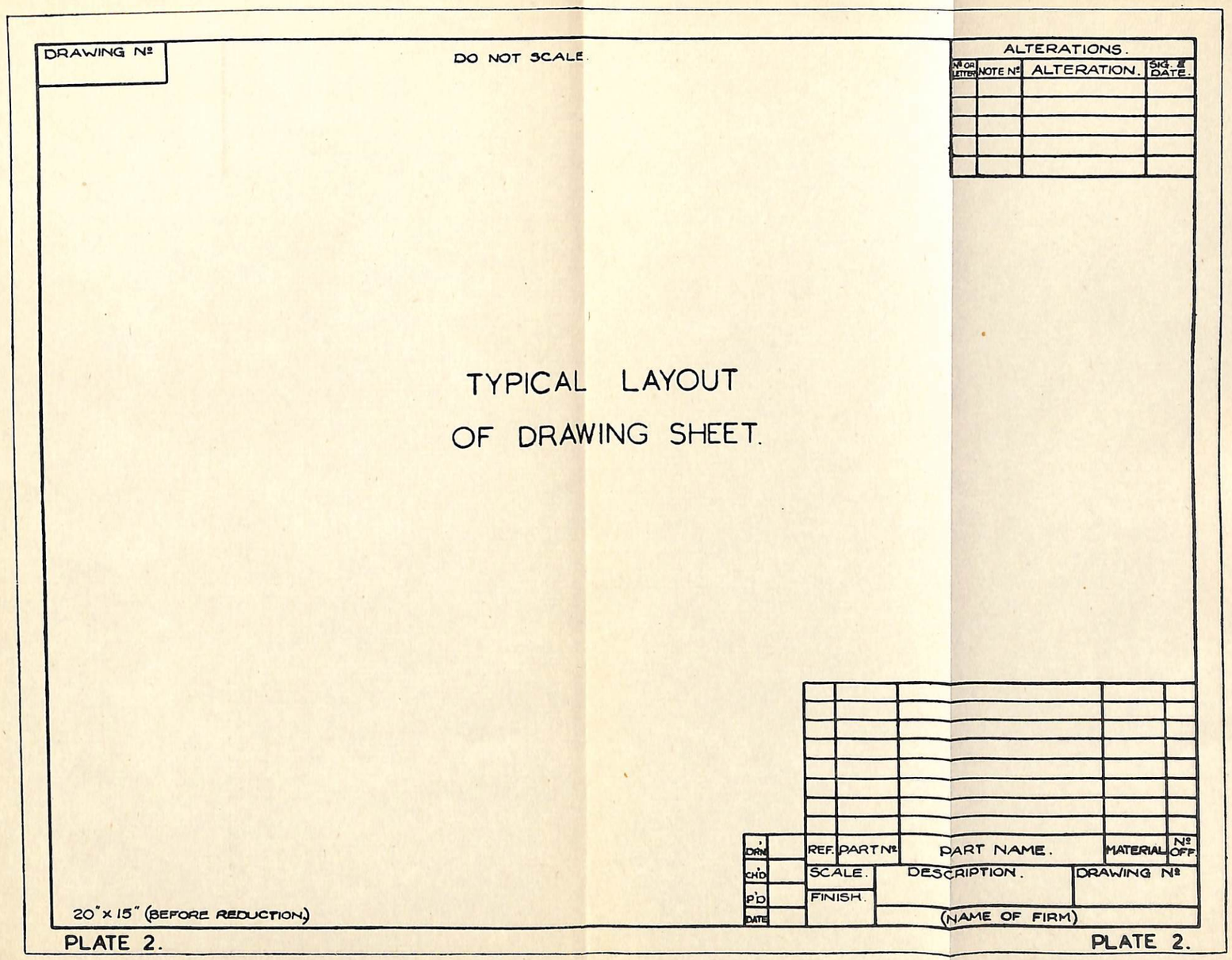
TYPICAL LAYOUT OF DRAWING SHEET.

UNLIMITED MACHINE DIMENSIONS TO BE WITHIN ±		MACHINING SYMBOLS ETC:-	
DRN	SCALE:-	MAT'L SPEC Nº	FORM & TREATMENT / FINISH.
CH'D		PART NAME.	DRG. OR PART Nº
P'D	ALL THREADS TO CONFORM TO B.S. SPEC Nº		
DATE		(NAME OF FIRM)	

20"x15" (BEFORE REDUCTION) DIMENSIONS ARE IN INCHES (WHERE APPROPRIATE)

PLATE 1.

PLATE 1.


DRAWING Nº
DO NOT SCALE.
ALTERATIONS.
Nº OR LETTER
NOTE Nº
ALTERATION.
SIG. & DATE.
TYPICAL LAYOUT
OF DRAWING SHEET.
REF.
PART Nº
PART NAME.
MATERIAL
Nº OFF.
DRN.
CH'D.
P'D.
DATE
SCALE.
FINISH.
DESCRIPTION.
DRAWING Nº
(NAME OF FIRM)
20" x 15" (BEFORE REDUCTION)
PLATE 2.
PLATE 2.

DRAWING Nº

DO NOT SCALE.

STOCK PARTS			
PART Nº	DESCRIPTION	Nº OFF PER SET	REMARKS

TYPICAL LAYOUT OF DRAWING SHEET.

ITEM Nº	NAME	Nº OFF.	REMARKS

SCALE:-

MACHINING SYMBOLS ETC:-

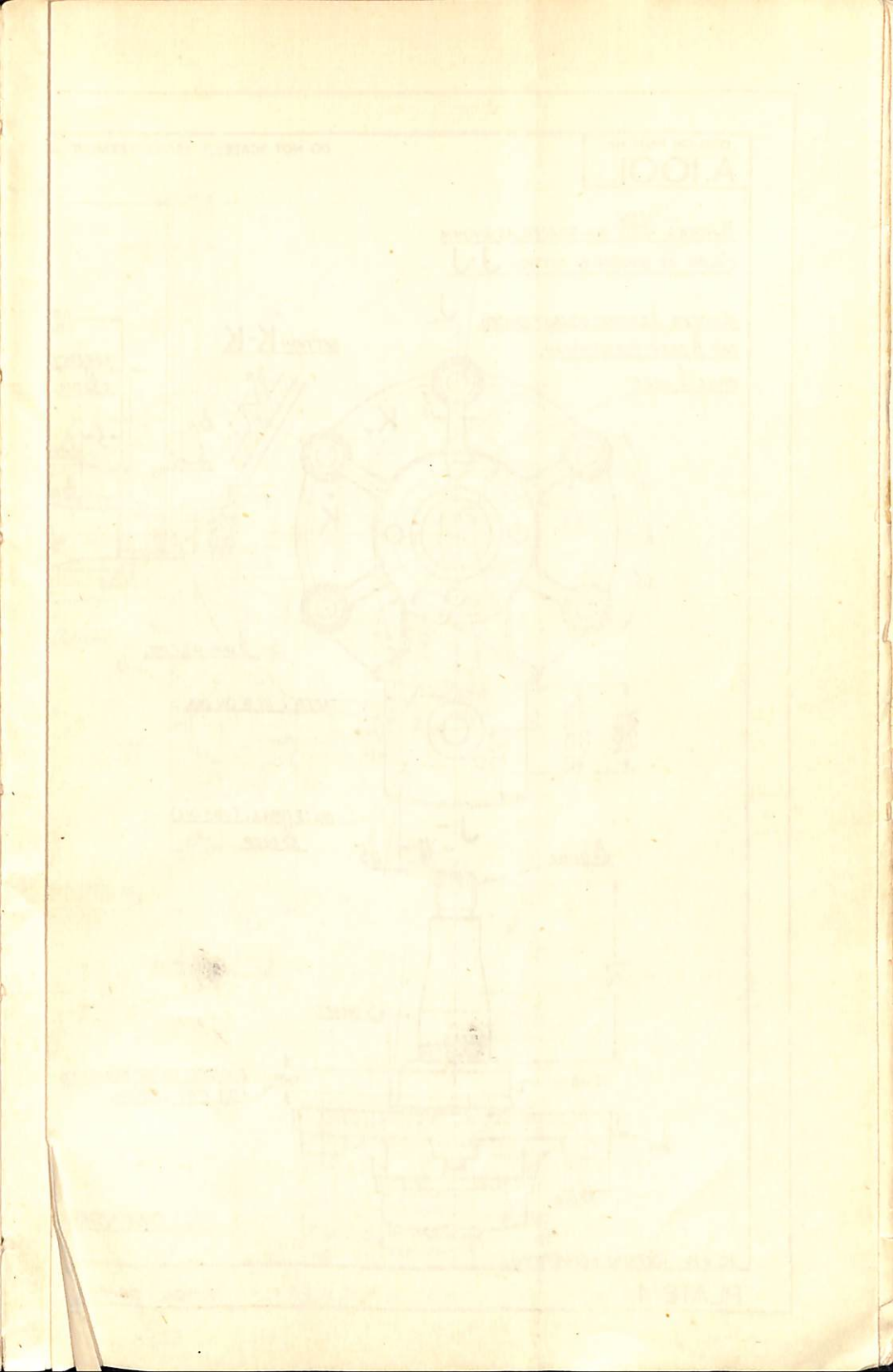
DR'N	FITS BRITISH STANDARD	HOLES BRITISH STANDARD	JOB Nº
CH'D			
P'D	OTHER ASSEMBLIES ON JOB.		DRAWING Nº
DATE	(NAME OF FIRM)		

20" x 15" (BEFORE REDUCTION.)

FOR PART Nº & NAME TITLE MACHINE. OPERATION.

PLATE 3

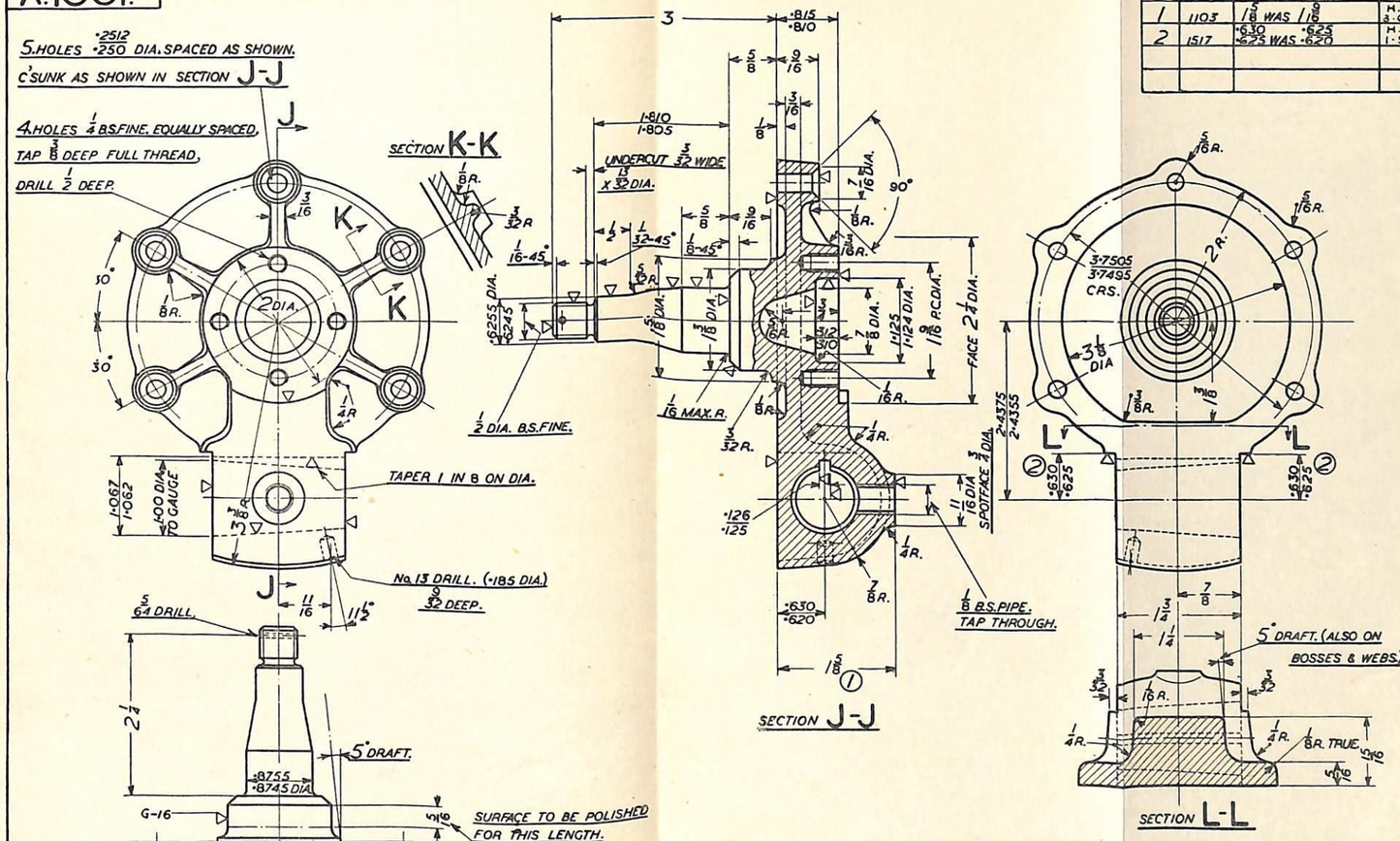
PLATE 3



DRG. OR PART No. A.1001.

DO NOT SCALE. REMOVE ALL BURRS & SHARP EDGES.

ALTERATIONS.			
No. OR LETTER	NOTE No.	ALTERATION.	SIG. & DATE.
1	1103	$\frac{5}{8}$ WAS $\frac{9}{16}$	H.G. 3.6.42.
2	1517	·630 ·625 WAS ·625 ·620	H.G. 1.9.42.


5 HOLES ·2512 ·250 DIA. SPACED AS SHOWN. C'SUNK AS SHOWN IN SECTION J-J
4 HOLES ¼ B.S.FINE. EQUALLY SPACED, TAP ⅜ DEEP FULL THREAD, DRILL ½ DEEP.
SECTION K-K
SECTION J-J
SECTION L-L
TAPER 1 IN 8 ON DIA.
No. 13 DRILL. (·185 DIA.) 9/32 DEEP.
UNDERCUT 5/32 WIDE X 13/32 DIA.
½ DIA. B.S.FINE.
⅛ B.S. PIPE. TAP THROUGH.
FACE 2¼ DIA.
5° DRAFT. (ALSO ON BOSSES & WEBS)
SURFACE TO BE POLISHED FOR THIS LENGTH.
5° DRAFT.
3·7505 3·7495 CRS.
2·4375 2·4355 DIA.
·8755 ·8745 DIA.
·1067 ·1062
·400 DIA. TO GAUGE
·6255 ·6245
1·8110 1·8105
·8/0 ·8/5
·630 ·625
·630 ·620
1·125 1·124 DIA.
⅛ R.C. DIA.
11/16 DIA. SPOTFACE ¾ DIA.
⅛ R. TRUE.
DIMENSIONS ARE IN INCHES.

UNLIMITED MACHINE DIMENSIONS TO BE WITHIN ±·010		MACHINING SYMBOLS ETC: TO B.S. SPECIFICATION No:	
DR'N A.A.	SCALE :- 1/1	MAT'L SPEC'N. B.S.E.N. 16 - V9.A.	FORM & TREATMENT. HEAT STAMPING. TREATED.
CH'D B.C.	ALL THREADS TO CONFORM TO B.S. SPEC'N	FINISH. PAINT GREY AFTER ASSEMBLY.	
P'D D.F.		PART NAME. BEARING STUB.	DRG. OR PART No. A.1001.
DATE 1·6·42		NAME OF FIRM	

20 x 15 (BEFORE REDUCTION)

PLATE 4.

TYPICAL DRAWING ILLUSTRATING CLAUSES 3, 6, 7, 8, 9, 11, 12, 13, 14, 15 & 19.

PLATE 4.

BRITISH STANDARDS INSTITUTION

The British Standards Institution was founded in 1901 and incorporated by Royal Charter in 1929.

The principal objects of the Institution are to co-ordinate the efforts of producers and users for the improvement, standardisation and simplification of engineering and industrial materials ; to simplify production and distribution ; to eliminate the waste of time and material involved in the production of an unnecessary variety of patterns and sizes of articles for one and the same purpose ; to set up standards of quality and dimensions, and promote the general adoption of British Standards.

In all its endeavours the Institution maintains the community of interest of purchaser and producer. It does not embark on any work without first ascertaining that there is a consensus of opinion in favour of its being proceeded with, and that it is to fulfil a recognised want.

This national work is carried on largely by means of grants received from the Government, professional institutions and industrial and trade organisations, as well as by sales of its publications. The amount derived from these sources is, however, not sufficient, and the Institution has to look to industry as a whole for the further funds necessary to enable it to meet the increasing demands made upon its organisation.

Membership of the Institution is open to British subjects, companies, technical and trade associations, and local and public authorities.

The Institution is not a profit-making concern, its only expenses being staff salaries, office expenses and printing.

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